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Final

Revised Feasibility Study for Parcel D

Hunters Point Shipyard
San Francisco, California

November 30, 2007

Volume I of II
Text, Figures, and Tables

Prepared for:
Base Realignment and Closure
Program Management Office West
San Diego, California

Prepared by:
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Prepared under:
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Dear BCT members:

Enclosure (1) is the Final Revised Feasibility Study for Parcel D. The Response to Comments on the Draft Final version of the document is included as Appendix J.

If you should you have any concerns with this matter, please contact Mr. Mark Walden at (619) 532-0931 or Mr. Keith Forman, at (619) 532-0913.

Sincerely,

KEITH FORMAN
BRAC Environmental Coordinator
By direction of the Director

Enclosure: 1. Final Revised Feasibility Study for Parcel D, November 30, 2007

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Public Summary: **Final Revised Feasibility Study for Parcel D**
Hunters Point Shipyard, San Francisco, California
November 30, 2007

The U.S. Department of the Navy conducted a feasibility study (FS) to evaluate remedial alternatives for Parcel D at Hunters Point Shipyard in San Francisco, California. A previous draft and draft final FS report for Parcel D were prepared in 1997; however, based on comments received during the FS public review period and concerns from the regulatory agencies, the Navy decided to conduct interim remedial actions, collect additional data, and perform further data evaluations before finalizing the FS report. This final revised FS report for Parcel D includes (1) updated data, (2) a revised human health risk assessment for Parcel D and an environmental evaluation of potential threats to the San Francisco Bay, and (3) a reevaluation of remedial alternatives based on these updates.

The Navy considered the following remedial alternatives for chemicals in soil at Parcel D: (1) no action; (2) institutional controls and maintained landscaping; (3) excavation, disposal, maintained landscaping, and institutional controls; (4) covers and institutional controls; and (5) excavation, disposal, covers, and institutional controls. The Navy considered the following remedial alternatives for chemicals in groundwater at Parcel D: (1) no action; (2) long-term monitoring of groundwater and institutional controls; and (3 and 4) two types of *in situ* treatment, reduced groundwater monitoring, and institutional controls.

Information Repositories: A complete copy of the "Final Revised Feasibility Study for Parcel D," dated November 30, 2007, is available to community members at:

San Francisco Main Library
100 Larkin Street
Government Information Center, 5th Floor
San Francisco, CA 94102
Phone: (415) 557-4500

Anna E. Waden Bayview Library
5075 Third Street
San Francisco, CA 94124
Phone: (415) 715-4100

The report is also available to community members on request to the U.S. Department of the Navy. For more information about environmental investigation and cleanup at Hunter Point Shipyard, contact Mark Walden, Remedial Project Manager for the Navy, at:

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PREPARED FOR:

DEPARTMENT OF THE NAVY

REVIEW AND APPROVAL

Project Manager: James W. Knight
James Knight, SulTech

Date: November 30, 2007

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ACRONYMS AND ABBREVIATIONS

§	Section
§§	Sections
μg/L	Microgram per liter
ARAR	Applicable or relevant and appropriate requirement
ARIC	Area requiring institutional controls
AST	Aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
Bay	San Francisco Bay
BCT	Base Realignment and Closure Cleanup Team
bgs	Below ground surface
BRAC	Base Realignment and Closure
Cal. Code Regs.	*California Code of Regulations*
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	Chemical of concern
COPC	Chemical of potential concern
COPEC	Chemical of potential environmental concern
DM	*De minimis*
DTSC	Department of Toxic Substances Control
EE	Exploratory excavation
ELCR	Excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	Feasibility study
GDGI	Groundwater data gaps investigation
GRA	General response action
HGAL	Hunters Point groundwater ambient level
HHRA	Human health risk assessment
HI	Hazard index
HPAL	Hunters Point ambient level
HPS	Hunters Point Shipyard
IR	Installation Restoration

IT Corp.	International Technology Corporation
ITSI	Innovative Technical Solutions, Inc.
LFR	Levine-Fricke-Recon, Inc.
LUC	Land use control
LUC RD	Land use control remedial design
MCL	Maximum contaminant level
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NRDL	National Radiological Defense Laboratory
O&M	Operation and maintenance
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
ppm	Part per million
PQL	Practical quantitation limit
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
RA	Remediation area
RAO	Remedial action objective
RASO	Radiological Affairs Support Office
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial investigation
RMP	Risk management plan
RMR	Risk management review
ROD	Record of decision
SVOC	Semivolatile organic compound
SWRCB	State Water Resources Control Board
TCRA	Time-critical removal action
TDS	Total dissolved solids
Tetra Tech	Tetra Tech EM Inc.

ACRONYMS AND ABBREVIATIONS (Continued)

tit.	Title
TPH	Total petroleum hydrocarbons
Triple A	Triple A Machine Shop, Inc.
U&A	Uribe & Associates
U.S.C.	*United States Code*
UST	Underground storage tank
VOC	Volatile organic compound
Water Board	San Francisco Bay Regional Water Quality Control Board
ZVI	Zero-valent iron

EXECUTIVE SUMMARY

The U.S. Department of Navy has prepared this final revised feasibility study (FS) to address soil and groundwater contamination at Parcel D in Hunters Point Shipyard (HPS). HPS is a deactivated shipyard on the San Francisco Bay (the Bay) in southeastern San Francisco, California. This report combines existing remedial investigation (RI) data with new data collected after the RI was completed in 1996 and a draft final FS report was completed in 1997. This final revised FS report updates the revised draft FS report for Parcel D completed in 2002. The data are summarized and evaluated in this revised FS report to refine the conceptual site model, further define the extent of contamination, and assess potential risks based on existing site conditions. This FS report includes (1) a revised human health risk assessment (HHRA) that incorporates revised protocols and procedures for conducting HHRAs at HPS agreed to by the Base Realignment and Closure Cleanup Team, (2) an evaluation of potential environmental impacts to the Bay based on comparison of groundwater data for Parcel D with available surface water quality criteria and a derivation of trigger levels for these potential environmental impacts as proposed action level criteria, (3) updated remedial action objectives that reflect the Conveyance Agreement between the Navy and the San Francisco Redevelopment Agency, and (4) development and evaluation of revised remedial alternatives that address soil and groundwater areas that pose a risk to human health or the environment.

Environmental activities at Parcel D were conducted under the Navy's Installation Restoration (IR) Program in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This executive summary discusses HPS background, Parcel D history and setting, Parcel D remedial activities, Parcel D revised HHRA, and the FS process for Parcel D.

HUNTERS POINT SHIPYARD BACKGROUND

HPS consists of 866 acres: 420 acres on land and 446 acres under water in the Bay. In 1940, the Navy obtained ownership of HPS for shipbuilding, repair, and maintenance activities. After World War II, activities at HPS shifted to submarine maintenance and repair. HPS was also the site of the Naval Radiological Defense Laboratory. HPS was deactivated in 1974 and remained relatively unused until 1976. Between 1976 and 1986, the Navy leased most of HPS to Triple A Machine Shop, Inc., a private ship repair company. In 1987, the Navy resumed occupancy of HPS.

Because past shipyard operations left hazardous materials on site, HPS property was placed on the National Priorities List in 1989 as a Superfund site pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act as amended by the Superfund Amendments and Reauthorization Act of 1986. In 1991, HPS was designated for closure pursuant to the Defense Base Closure and Realignment Act of 1990. Closure activities at HPS involve conducting environmental remediation and making the property available for nondefense use.

PARCEL D HISTORY AND SETTING

Parcel D is bounded by other portions of HPS, private property, and by the Bay. Most of Parcel D was formerly part of the industrial support area and was used for shipping, ship repair, and office and commercial activities. The docks at Parcel D were formerly part of the industrial production area. According to the City and County of San Francisco's Redevelopment Plan, Parcel D will be zoned for the following reuses: educational and cultural, mixed uses, research and development, open space, industrial, and maritime industrial (see Figure ES-1). Evaluation of the currently proposed football stadium plan at HPS was not part of the scope of this report. However, information provided in this FS report is relevant to a stadium reuse plan at Parcel D. The HHRA includes scenarios for alternative reuse, including industrial reuse and recreational reuse, for the entire parcel. The industrial reuse scenario is conservative for the areas of the stadium complex that are regularly occupied, and the recreational scenario is appropriate for the remainder of the parcel.

Historically, Parcel D was investigated by IR site. Parcel D originally consisted of 27 IR sites, which were investigated during the RI. Since that time, the Parcel D boundaries have been redefined resulting in four IR sites (IR-08, IR-36, IR-38, and IR-39) no longer being within Parcel D, resulting in 23 IR sites in Parcel D. Sites IR-45 (steam line system) and IR-50 (storm drain and sanitary sewer system) are facility-wide utility sites that traverse other sites. Site IR-51 is a facility-wide site consisting of buildings and areas that formerly housed electrical transformers. To help identify areas of Parcel D associated with specific planned reuses, Parcel D is also divided into redevelopment blocks with assigned redevelopment block numbers. The revised HHRA and the proposed application of remedial alternatives are based on redevelopment blocks. For each redevelopment block at Parcel D, the table below lists the associated IR sites, the planned reuses, and the HHRA exposure scenario.

PARCEL D IR SITES

09	37	65
16	44	66
17	45	67
22	48	68
32	50	69
33	51	70
34	53	71
35	55	

Redevelopment Block	IR Sites	Planned Reuse	HHRA Exposure Scenario
DMI-1	16, 17, 22, 32, 35, 53, 55, 68, 69, and 70	Maritime Industrial	Industrial
30B	Part of 37	Industrial	
37	66 and 67	Industrial	
38	33 and 44	Industrial	
42	48	Industrial	
29	09 and part of 33	Educational/Cultural	
DOS-1	Part of 33 and 34	Open Space	Recreational
39	34, 65, and 71	Open Space	
A	None	Research and Development	Residential
30A	Part of 37	Mixed Use	

More than 80 percent of HPS consists of relatively level lowlands that were mostly constructed by placing borrowed fill material from a variety of sources, including serpentinite bedrock from the shipyard. The serpentinite bedrock and serpentine bedrock-derived fill material are comprised of minerals that naturally contain relatively high levels of arsenic, manganese, nickel, and other metals. The fill supported new buildings, construction, and in some cases filled the margin of the Bay. Nearly 100 percent of Parcel D is located in the lowlands, with surface elevations between 0 to 10 feet above mean sea level. No threatened or endangered species are known to inhabit HPS or its vicinity. In 2004, a burrowing owl, a species of special concern according to the California Department of Fish and Game, was sighted at Parcel D. The owl was passively relocated off Parcel D in 2005. Parcel D ecology is limited to those plant and animal species adapted to the industrial environment. Viable terrestrial habitat is inhibited at Parcel D because approximately 85 percent of the ground surface is covered by pavement and industrial buildings. Physical structures at Parcel D, such as docks and piers, may serve as artificial habitats for estuarine life.

The geologic setting at Parcel D is as follows. In general, the stratigraphic sequence of geologic units present at Parcel D, from youngest (shallowest) to oldest (deepest), is Artificial Fill; Undifferentiated Upper Sand Deposits; Bay Mud Deposits; Undifferentiated Sedimentary Deposits; and Franciscan Complex Bedrock. The hydrostratigraphic units present at Parcel D are the A-aquifer, the aquitard zone, the B-aquifer, and a bedrock water-bearing zone. There are no current beneficial uses of the groundwater at HPS, and the beneficial use evaluation in this FS report recommends that the groundwater from the shallowest A-aquifer be considered for non-beneficial use, and the groundwater from the underlying B-aquifer have a low potential for beneficial use.

PARCEL D REMEDIAL ACTIVITIES UNDER COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

The RI for Parcel D was conducted from 1988 to 1996. In addition, the Navy has conducted a number of removal actions (see adjacent box) that reduced or eliminated certain risks to human health and ecological receptors at Parcel D. The draft final Parcel D RI report was submitted to the regulatory agencies on October 25, 1996. The FS was conducted concurrently with the RI, and the draft final Parcel D FS report was submitted to the regulatory agencies on January 24, 1997. A proposed remedial plan for Parcel D was completed in 1997, including a public review and comment period. Based on comments received during the public review period and on concerns from the regulatory agencies, the Navy decided to conduct additional removal actions to mitigate areas of contaminated soil, collect additional data, and perform further data evaluations before finalizing the FS report. A draft revised FS report for Parcel D was prepared in 2002 based on the removal actions and additional data collected since the conclusion of the RI report. This final

REMOVAL ACTIONS AT PARCEL D

- **Phase I and II Underground Storage Tank Removal Action, 1991-1993:** Nine underground storage tanks were removed and 1 closed in place.
- **Sandblast Grit Removal Action, 1991-1995:** A total of 4,665 tons of discarded sandblast grit was removed.
- **Pickling and Plate Yard Removal Action, 1994-1996:** Contaminated equipment and residue were removed at IR-09.
- **Exploratory Excavation Removal Action, 1996-1997:** Stained soil, asphalt, and concrete were removed from four IR sites (IR-33, IR-37, IR-70 and IR-53).
- **Storm Drain Sediment Removal Action, 1996-1997:** A total of 1,200 tons of contaminated sediment was removed from storm drain lines and appurtenances.
- **Time-Critical Removal Action, 2000-2001:** A total of 1,643 cubic yards of soil was removed from several IR sites (IR-09, IR-37, IR-53, IR-55 and IR-65).
- **Radiological Time-Critical Removal Action, 2001 – present (ongoing):** In 2001, soil impacted by cesium-137 spill was removed from Building 364 and the surrounding area. Investigation and remediation is ongoing.
- **Soil Stockpile Removal Action, 2003-2004:** Nine soil and asphalt stockpiles were removed.
- **Storm Drain and Sanitary Sewer Removal Action, 2007- present (ongoing):** Radiologica investigation and removal of storm drains and sanitary sewers.

revised FS report for Parcel D includes an update to the site characterization and a revised HHRA and environmental evaluation for Parcel D, and based on these updates, a reevaluation of the remedial alternatives.

REVISED HUMAN HEALTH RISK ASSESSMENT AND ENVIRONMENTAL EVALUATION

The HHRA presented in this FS report revises the HHRA presented in the 2002 draft revised FS for Parcel D to account for the soil data collected during the 2004 time-critical removal action, and to incorporate changes in regulatory guidance and toxicological criteria that have occurred since the previous HHRA. Soil data associated with sampling locations excavated and removed from HPS during the 2000, 2001, and 2004 time-critical removal actions are excluded from the HHRA, and additional groundwater data collected since the 2002 HHRA are included in the revised HHRA. Lastly, revisions were made to the HHRA based on HPS Base Realignment and Closure Cleanup Team agreements formulated in 2003 and 2004.

The HHRA estimated cancer risks and noncancer hazards from exposure to chemicals of potential concern in all affected environmental media for each pathway identified as potentially complete. Both total and incremental risks were evaluated for exposure to soil at Parcel D. For the total risk evaluation, all detected chemicals, including naturally occurring metals from the serpentine bedrock-derived fill material, were included as chemicals of potential concern regardless of their concentration. Only the essential nutrients calcium, magnesium, potassium, and sodium were not included as chemicals of potential concern. The total risk evaluation provides an estimate of the risks posed by chemicals at the site, including those present at concentrations at or below ambient levels. For the incremental risk evaluation, the above essential nutrients were excluded as soil chemicals of potential concern, as well as the detected metals with maximum measured concentrations below the Hunters Point ambient levels. The incremental risk evaluation provides an estimate of risks posed by metals present at the site that are above the estimated ambient levels. Those chemicals at Parcel D determined to pose a potential unacceptable risk were identified as chemicals of concern. Potential unacceptable risk is defined as an excess lifetime cancer risk of greater than 1×10^{-6} or a segregated hazard index greater than 1 determined by the incremental risk evaluation.

The total risk results for soil show that most exposure areas exceed the excess lifetime cancer risk threshold of 10^{-6}, based on the planned reuse. The predominant cancer risk driver is arsenic, which is ubiquitous in the fill material. Planned reuse for Parcel D as developed by the San Francisco Redevelopment Agency includes mixed use, industrial, maritime industrial, educational/cultural, and open space. For exposure areas planned for residential reuse, the total hazard index for all areas for which data are available also exceeds the threshold segregated hazard index of 1. Under the incremental risk evaluation, most exposure areas at Parcel D do not exceed the cancer risk threshold of 10^{-6} or the noncancer threshold segregated hazard index of 1, based on the planned reuse. The chemicals of concern in soil at Parcel D are arsenic, lead, manganese, benzo(a)pyrene, and benzo(b)fluoranthene.

The HHRA results for groundwater show that the risk from exposure to A-aquifer groundwater via vapor intrusion exceeds the cancer risk threshold of 10^{-6} in those areas where volatile organic compounds (VOC) are present in the following reuse areas: residential, mixed use, industrial, educational/cultural, and maritime industrial. The chemicals of concern in groundwater from the vapor intrusion pathway are benzene, carbon tetrachloride, chloroform, methylene chloride, naphthalene, tetrachloroethene, trichloroethene, and xylenes.

In addition, the HHRA results for groundwater show that the risk from exposure to the A-aquifer groundwater via dermal exposure and inhalation to the construction workers exceeds the cancer risk threshold of 10^{-6} in areas with elevated concentrations of the chemicals of concern. These chemicals of concern from this exposure pathway are arsenic, benzene, naphthalene, tetrachloroethene, and xylenes.

The B-aquifer was evaluated for all chemicals of potential concern through the domestic use of groundwater pathway. No unacceptable risk was found from this exposure scenario; therefore, no chemicals of concern are associated with the B-aquifer.

In addition to the HHRA, an environmental evaluation was performed to identify potential threats to the Bay from chemicals present in groundwater at Parcel D. A list of surface water criteria was derived from available federal and state regulations and guidance. These criteria were compared to all historical groundwater sample data to identify those chemicals detected in groundwater that exceeded the surface water criteria levels. Further evaluation was performed for each chemical of potential concern to determine if it was a chemical of concern that posed a current potential threat to the Bay. Chromium VI and nickel were determined to be chemicals of concern in the A-aquifer based on potential threats to the Bay.

FEASIBILITY STUDY PROCESS

The general process used to conduct this FS consists of the following steps: develop remediation goals, develop remedial action objectives, identify general response actions, identify areas requiring remediation, and evaluate alternatives based on the nine evaluation criteria under the NCP. Each of these steps is discussed in the following paragraphs.

Develop Remediation Goals and Trigger Levels

Remediation goals were developed for each human health chemical of concern by comparing the highest concentrations of acceptable incremental risk with both the laboratory's reporting limit and the ambient level for the chemical of concern, if one was established. The greatest value for this comparison was determined to be the remediation goal for that chemical of concern. Remediation goals were derived for both soil and groundwater from the HHRA.

Trigger levels were developed for each environmental chemical of concern in the A-aquifer to determine if further action was needed for the chromium VI and nickel plumes that posed potential threats to the Bay. To assess these potential threats, groundwater modeling was conducted to derive plume-specific attenuation factors. The resulting attenuation factors are multiplication factors that predict conservative reductions in the plume's concentration as it migrates to the Bay. The attenuation factors were used with the surface water criteria to derive a plume- and analyte-specific trigger level as a conservative maximum concentration that could be found at the plume source, which would attenuate during its migration to the Bay to a concentration that would not exceed the surface water criteria or impact the Bay. These trigger levels were compared to the maximum concentrations of chromium VI and nickel found at the plume source to assess their potential threats to the Bay.

Develop Remedial Action Objectives

Remedial action objectives for Parcel D are medium-specific goals that were developed from the incremental risk assessment for protecting human health and from the trigger level comparison for protecting the surface water in the Bay. Each remedial action objective specified (1) the chemicals of concern, (2) the exposure route and receptors, and (3) an acceptable contaminant concentration or range of concentrations for media of concern (such as soil and groundwater).

Soil Remedial Action Objectives

Soil remedial action objectives are developed based on human health receptors and the incremental risk assessment. For Parcel D, no ecological soil remedial action objectives were developed because most of the land area is paved, the parcel contains no identified terrestrial habitat, and there is insufficient unpaved area to develop a terrestrial ecological habitat. The following remedial action objective applies to the Parcel D soil:

1. Prevent exposure to organic and inorganic compounds in soil above the remediation goals developed in the HHRA for carcinogens or noncarcinogens for the following exposure pathways:
   - Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 10 feet below ground surface (bgs) by residents in areas zoned for mixed use reuse
   - Ingestion of home-grown produce by residents in areas zoned for mixed use reuse
   - Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to10 feet bgs by industrial workers in areas zoned for educational, cultural, industrial, and maritime industrial reuse
   - Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 2 feet bgs by recreational users in areas zoned for open space reuse
   - Soil ingestion, outdoor air inhalation, and dermal exposure to soil from 0 to 10 feet bgs by construction workers in all areas
2. Prevent exposure to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors. Remediation goals for soil gas will be established during the remedial design.

Groundwater Remedial Action Objectives

Remedial action objectives for Parcel D groundwater were evaluated based on (1) the incremental human health risks through the inhalation of VOCs in indoor air (vapor intrusion) from the A-aquifer groundwater, (2) the potential risks associated with the domestic use exposure pathway from the B-aquifer even though there are no chemicals of concern in the B-aquifer, (3) the incremental human health risks to construction workers from dermal exposure and inhalation, and (4) potential migration to the Bay of chemicals of concern above the plume-specific trigger levels. The following remedial action objectives apply to groundwater at Parcel D:

1. Prevent exposure to VOCs in A-aquifer groundwater above remediation goals via indoor inhalation of vapors from groundwater.
2. Prevent direct exposure to the groundwater that may contain chemicals of concern through the domestic use pathway.
3. Prevent or minimize exposure to metals and VOCs in A-aquifer groundwater from dermal exposure and inhalation of vapors from groundwater by construction workers above remediation goals.
4. Prevent or minimize migration of chromium VI and nickel to prevent discharge that would result in concentrations of chromium VI above 50 micrograms per liter (μg/L) and nickel concentrations above 96.5 μg/L in the Bay.

Remedial action objectives for a stadium reuse would be similar to the soil and groundwater objectives stated above. Chemicals of concern and cleanup goals would likely be based on contamination to 2 feet, consistent with recreational reuse and plans for complete covers across the site. Remedial action objectives for groundwater would be based on the recreational scenario across the bulk of the parcel, minimizing the need for remediation of VOCs in groundwater outside of the stadium footprint.

Identify General Response Actions

General response actions are responses or remedies intended to meet remedial action objectives. General response actions identified for Parcel D soil and groundwater include no action, institutional controls, removal and disposal, treatment, and containment. Process options were then initially screened and then analyzed in detail to determine those technologies and processes that were appropriate to address chemicals of concern at Parcel D. Based on this screening and evaluation, soil treatment technologies and groundwater containment technologies were eliminated from further consideration.

Identify Remedial Alternatives

All process options retained after the initial screenings and detailed analysis were determined to meet the applicable or relevant and appropriate requirements (ARAR), and the remedial action objectives. Remedial alternatives were then derived using experience and engineering judgment that formulated the process options into the most plausible site-specific remedial actions. The soil and groundwater alternatives developed for further analysis are presented below.

Alternative S-1: No Action: For this alternative, no remedial action would be taken for soils. Soil would be left in place without implementing any response actions. The no-action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives.

Alternative S-2: Institutional Controls and Maintained Landscaping: Alternative S-2 consists of institutional controls for soils, consisting of access restrictions, land use restrictions, engineering controls, and covenants to restrict use of property that will be implemented parcel-wide for all of the redevelopment blocks. Alternative S-2 also includes maintained landscaping. Maintained landscaping will be required for areas that are currently bare or minimally vegetated soil that has been disturbed by excavation or construction activities and not restored with a cover (for example, clean imported soil, asphalt, or concrete).

Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls: Alternative S-3 consists of soil excavation, soil disposal, maintained landscaping, and institutional controls for soils similar to those of Alternative S-2. In areas where lead and polynuclear aromatic hydrocarbons are chemicals of concern, excavations will be performed to remediate these chemicals of concern to their respective remediation goals. This alternative will provide a more permanent remedy to reduce the volume and toxicity of contaminants present in onsite soils where excavation is feasible. Parcel-wide institutional controls for soils will also be applied to mitigate the risk exposure to other chemicals of concern that are not practical to remediate by excavation and disposal. Areas of bare or minimally vegetated soil that have been disturbed by excavation or construction activities and not restored with a cover will be covered by maintained landscaping as described in Alternative S-2.

Alternative S-4: Covers and Institutional Controls: Alternative S-4 consists of covers to eliminate the exposure pathway to soil contaminants, and institutional controls for soils. This alternative provides physical barriers to cut off the soil exposure pathways at Parcel D. Covers included in this alternative may include new covers and existing or future building footprints, roads, parking lots, and maintained landscape. These covers function to block exposure to metals in the fill material. The health risk due to arsenic and other metals is clearly demonstrated by the HHRA. Therefore, the covers and institutional controls that require their maintenance will be effective in preventing exposure. Institutional controls for soils are included in this alternative for both short-term and long-term mitigation of risk exposure. In addition to institutional controls similar to those required for Alternative S-2, institutional controls will also be applied that would require maintenance of the covers.

Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls: Alternative S-5 consists of a combination of soil excavation and disposal, covers, and institutional controls for soils. This alternative was developed as a combined alternative to (1) remove and dispose of lead and polynuclear aromatic hydrocarbons as described in Alternative S-3, (2) implement and maintain block-wide covers as described in Alternative S-4, and (3) implement the appropriate institutional controls for soils.

Alternative GW-1: No Action: For this alternative, no remedial action will be taken for groundwater. Groundwater conditions will be left as is, without implementing any response actions. The no-action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives.

Alternative GW-2: Long-Term Monitoring of Groundwater and Institutional Controls: Alternative GW-2 consists of groundwater monitoring and institutional controls for groundwater. This alternative was developed as a method for monitoring groundwater contaminants present at low concentrations.. Additionally, groundwater monitoring will be used to confirm site conditions and ensure that, over time, the potential exposure pathways remain incomplete. Institutional controls are also included in this alternative to effectively manage risk by preventing exposure and use of the groundwater.

Alternatives GW-3A and GW-3B: *In Situ* Treatment for VOCs, Groundwater Monitoring for Metals and VOCs, and Institutional Controls: Alternatives GW-3A and GW-3B consist of *in situ* treatment of the VOC contaminant plumes, in addition to groundwater monitoring for metals and VOCs and institutional controls for groundwater similar to those described for Alternative GW-2. Alternatives GW-3A and GW-3B involve using two different *in situ* treatment reagents, (1) a biological substrate, and (2) a slurry of zero-valent iron (ZVI). Alternative GW-3A uses a slow-release biological substrate designed to promote anaerobic bioremediation to degrade chlorinated chemicals of concern to nontoxic compounds. Alternative GW-3B uses ZVI slurry as an additive that creates a chemically reducing environment in the aquifer that mineralizes chlorinated chemicals similar to the bioremediation reaction. Alternatives GW-3A and GW-3B consider *in situ* treatment only for VOCs; metal would be monitored but not treated under this alternative. Monitoring for VOCs would be conducted to assess the effectiveness of the treatment. Alternatives GW-3A and GW-3B are intended to reduce the required time to meet the groundwater remedial action objectives for VOCs, and, as a result, the length of groundwater monitoring for VOCs and possibly the time required for the institutional controls for VOC issues. The institutional controls for groundwater in Alternatives GW-3A and GW-3B would be similar to the institutional controls in Alternative GW-2.

Alternatives GW-4A and GW-4B: *In Situ* Treatment for VOCs and Metals, Groundwater Monitoring, and Institutional Controls: Alternatives GW-4A and GW-4B consist of *in situ* treatment for both VOC and metal contaminant plumes in addition to groundwater monitoring and institutional controls for groundwater. Alternatives GW-4A and GW-4B involve using biological and ZVI *in situ* treatment reagents for VOCs and metals as described in Alternatives GW-3A and GW-3B. Although the technologies for Alternatives GW-4A and GW-4B are the same as those indicated under Alternatives GW-3A and GW-3B, the reagent materials and volumes are adjusted under Alternatives GW-4A and GW-4B to effectively treat metals. Alternative GW-4A uses a slow-release substrate to degrade chlorinated chemicals of concern as in Alternative GW-3A, and a similar bioremediation substrate that mitigates dissolved metals from the aquifer by creating biosulfur complexes that are readily sorbed to the soils. Alternative GW-4B uses zero-valent iron slurry as in Alternative 3B to create a chemically reducing environment that mineralizes chlorinated chemicals, and creates a chemically reducing environment in the aquifer that changes dissolved chromium VI to a less hazardous chromium III state, and removes nickel from the groundwater through precipitation. Alternatives GW-4A and GW-4B would take the most active approach toward reducing groundwater contaminant volume and toxicity, rather than only monitoring as proposed in Alternative GW-2 or treating only VOCs in Alternatives GW-3A and GW-3B. Alternatives GW-4A and GW-4B are intended to further reduce the time to meet the groundwater RAOs for all chemicals of concern, the length of groundwater monitoring, and the time required for the institutional controls. The institutional controls for groundwater in Alternatives GW-4A and GW-4B would be similar to the institutional controls in Alternative GW-2.

Alternatives would become simpler under the stadium reuse plan. Fewer areas would be planned for excavation under Alternatives S-3 and S-5 because of the change to the shallower 2-foot depth. Alternative S-4 would be unchanged at this time, but the type of cover would be determined during the remedial design. Groundwater alternatives would not be affected, except that the areas determined to require remediation would likely be smaller because of the recreational reuse.

Evaluation of Alternatives Based on Evaluation Criteria under the National Oil and Hazardous Substances Pollution Contingency Plan

Each remedial alternative was evaluated in comparison to the two threshold and five balancing evaluation criteria under the NCP (see adjacent box). Evaluation of the two modifying criteria of regulatory agency and community acceptance will be included in the record of decision following issue of the proposed plan and public comment period. These criteria are not evaluated in this final Parcel D revised FS report. A comparative analysis was conducted to evaluate the relative performance of the five soil and three groundwater remedial alternatives developed for Parcel D.

NCP EVALUATION CRITERIA

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of mobility, toxicity, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria

- Regulatory agency acceptance
- Community acceptance

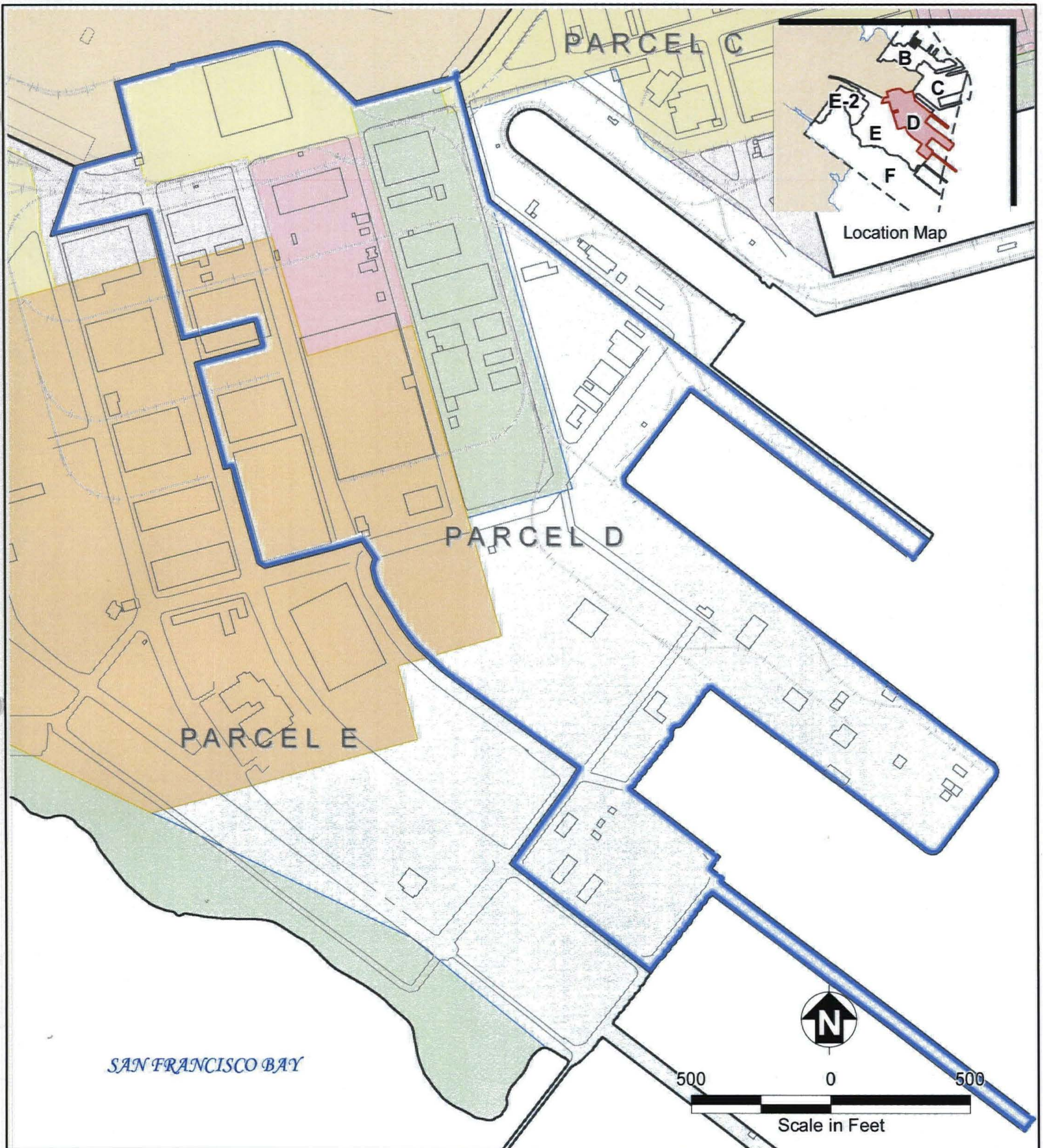
Evaluation Results for Soil and Groundwater Alternatives

An overall rating was assigned to each alternative. Alternatives S-2 through S-5 meet the threshold criteria. Alternative S-5 is rated between very good and excellent overall for the five balancing evaluation criteria under the NCP. Alternative S-5 is the most effective, with both excavation and covers, although it has the highest cost ($5.5 million). Alternative S-3, rated very good, is more effective than Alternative S-2 because contaminants are removed. The cost of Alternative S-3 ($1.81 million) is somewhat more expensive than that of Alternative S-2 ($820,000). Alternative S-4, rated very good, is considerably more expensive but is also more protective than Alternatives S-2 or S-3 ($4.54 million). Alternative S-2, rated good, is easiest to implement and least expensive. Alternative S-1 does not meet the threshold criteria and is thus rated poor.

Alternative GW-3A and GW-4A both have the highest overall rating of between very good and excellent with Alternative GW-4A being slightly higher. These treatments effectively reduce risks to human health and environment, and have similar costs (GW-3A of $2.45 million and GW-4A of $2.87 million). In the long term, Alternative GW-4A is more likely expected to achieve remedial action objectives than Alternative GW-3A because the latter alternative does not actively treat metals in groundwater. Alternative GW-3B ranks very good, but has a higher cost ($5.35 million) and does not actively treat metals in groundwater. Alternative GW-4B ranks very good also, but at an even higher cost ($9.20 million). Alternative GW-2 is easy to implement at a cost similar to Alternatives GW-3A and GW-3B ($3.52 million), but it is not as effective as Alternatives GW-3A, GW-3B, GW-4A, and GW-4B. Alternative GW-1 is rated as a poor alternative because it does not meet the threshold criteria.

Table ES-1 summarizes each alternative's rating under the seven evaluation criteria. The ranking categories used in Table ES-1 and in the discussion of the alternatives are (1) protective or not protective, and meets ARARs or does not meet ARARs, for the two threshold criteria; and (2) excellent, very good, good, marginal, and poor for the five balancing criteria.

FIGURES



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Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE ES-1
PROPOSED REUSE AT PARCEL D

Revised Feasibility Study Report for Parcel D

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TABLES

TABLE ES-1: RANKING OF REMEDIAL ALTERNATIVES FOR SOIL AND GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

	Overall Protection of Human Health and the Environment[a]	Compliance with ARARs[a]	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost	Overall Rank by Alternative
SOIL ALTERNATIVES								
Alternative S-1: No Action	Not protective	Not Applicable	○	○	◕	●	●	◑
Alternative S-2: Institutional Controls and Maintained Landscaping	Protective	Meets ARARs	◑	○	◕	◑	●	◕
Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls	Protective	Meets ARARs	◑	○	◕	◕	◕	◕
Alternative S-4: Covers and Institutional Controls	Protective	Meets ARARs	◕	○	◕	◕	◑	◕
Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls	Protective	Meets ARARs	●	○	●	◕	◑	◕
GROUNDWATER ALTERNATIVES								
Alternative GW-1: No Action	Not protective	Not Applicable	○	○	◑	●	●	◑
Alternative GW-2: Long-Term Monitoring and Institutional Controls	Protective	Meets ARARs	◑	○	◕	◕	◑	◕
Alternative GW-3A: In-Situ Treatment for VOCs with a Bioremediation Compound with Reduced Groundwater Monitoring and Institutional Controls	Protective	Meets ARARs	◕	◑	◕	◕	◑	◕
Alternative GW-3B: In-Situ Treatment for VOCs with ZVI Injection with Reduced Groundwater Monitoring and Institutional Controls	Protective	Meets ARARs	◕	◑	◕	◕	◔	◕
Alternative GW-4A: In-Situ Treatment for VOCs and Metals with Bioremediation Compound with Reduced Groundwater Monitoring, and Institutional Controls	Protective	Meets ARARs	●	●	◕	◕	◑	●
Alternative GW-4B: In-Situ Treatment for VOCs and Metals with ZVI Injection with Reduced Groundwater Monitoring and Institutional Controls	Protective	Meets ARARs	●	●	◕	◕	○	◕

Notes:

a Overall protection of human health and the environment and compliance with ARARRs are threshold criteria and alternatives are judged as either meeting or not meeting the criteria.
ARAR Applicable or relevant and appropriate requirement
ZVI Zero-valent iron

Legend:
○ Poor
◔ Marginal
◑ Good
◕ Very Good
● Excellent

1.0 INTRODUCTION

In 1989, the U.S. Environmental Protection Agency (EPA) identified Hunters Point Shipyard (HPS) in San Francisco, California (see Figure 1-1), as a National Priorities List site. As a result, the U.S. Department of the Navy is conducting investigations in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Title 42 *United States Code* [U.S.C.] Sections [§§] 9601-9675) at a number of sites at HPS. As a management tool to accelerate site investigation, cleanup, and reuse, HPS was divided into Parcels A through F.

This feasibility study (FS) is part of ongoing efforts by the Navy to address contamination in Parcel D at HPS in accordance with CERCLA. The FS is a mechanism for developing, screening, and evaluating alternatives for remedial actions to address risk identified during a remedial investigation (RI) under the CERCLA process. In addition, the FS documents risk management decisions made by the stakeholders. As the lead agency, the Navy is working with EPA Region 9, the Department of Toxic Substances Control (DTSC), and the San Francisco Bay Regional Water Quality Control Board (Water Board) to develop and implement the remedial alternatives in this FS report. The Navy, EPA, DTSC, and Water Board representatives are collectively referred to as the Base Realignment and Closure (BRAC) Cleanup Team (BCT) for HPS.

A previous draft and draft final FS report for Parcel D were prepared in 1997; however, based on comments received during the FS public review period and concerns from the regulatory agencies, the Navy decided to conduct interim remedial actions, collect additional data, and perform further data evaluations before finalizing the FS report. This final revised FS report for Parcel D includes (1) an update to the site characterization, (2) a revised human health risk assessment (HHRA) and an evaluation of potential environmental impacts on the San Francisco Bay (the Bay), (3) updated remedial action objectives (RAO) that reflect the Conveyance Agreement between the Navy and the San Francisco Redevelopment Agency (2004), and (4) development and evaluation of revised remedial alternatives, which address soil and groundwater areas that pose a risk to human health or the environment based on these updates.

Parcel D is one of seven parcels designated by the Navy for HPS: A, B, C, D, E, E-2, and F. The Navy proposed dividing HPS into separate parcels to conduct RIs and FSs, and to expedite remedial actions in support of transferring the property. As a result, the Navy has currently divided the facility into seven contiguous parcels. In December 2004, the Navy transferred Parcel A to the San Francisco Redevelopment Agency; the remaining six parcels are shown on Figure 1-2. Parcel D has undergone several boundary changes: in April 1997, Installation Restoration (IR) Site 36 was transferred from Parcel D to Parcel E; in March 2004, a portion of Parcel A was transferred to Parcel D; and in February 2005, selected areas from Parcel D were transferred to Parcel E. This final revised FS report addresses the area within the Parcel D boundary as redefined in February 2005.

Initially, areas with potential environmental concern were designated as IR sites, and were in most cases identified by a two-digit number, for example, IR-33. Site characterization activities and sampling data were mostly planned and organized by IR site. To assess risk, the BCT agreed to divide all of HPS into two different size grids (industrial and residential) as a method of statistically calculating risk within an area for different future land use scenarios. In conjunction with the basewide risk grid layout, the San Francisco Redevelopment Agency designated redevelopment blocks for Parcel D in accordance with the City of San Francisco's planned future reuse. This revised FS report uses the risk grids and the redevelopment blocks as the basis for evaluating the results of the HHRA and developing remedial alternatives to address potential unacceptable risk present within Parcel D. Potential unacceptable risk is defined as an excess lifetime cancer risk of greater than 1×10^{-6} or a segregated hazard index (HI) greater than 1 determined by the incremental risk evaluation. IR sites are still referred to in the characterization sections of this FS report as they relate to historical operations and resulting sources of contamination found in Parcel D soil and groundwater.

Section 1.1 summarizes the history current status of CERCLA activities at Parcel D, including the current status of this final revised FS report. The purpose and organization of this FS report are presented in Section 1.2.

1.1 HISTORY OF CERCLA ENVIRONMENTAL STUDIES AT PARCEL D

The CERCLA remedial process consists of several progressive steps for achieving cleanup of the environmental issues at and release of the site for future reuse. The typical sequence is as follows: RI, FS, proposed plan, public comment period, record of decision (ROD), remedial design (RD), and remedial action. Removal actions are also used at times to expedite the cleanup process.

An RI, FS, proposed plan, and public comment period were completed for Parcel D. The initial RI for Parcel D was conducted from 1988 to 1996, and a draft final RI report was submitted to the regulatory agencies on October 25, 1996 (PRC Environmental Management, Inc. [PRC], Levine-Fricke-Recon, Inc. [LFR], and Uribe & Associates [U&A] 1996). That RI report concluded that the groundwater at Parcel D did not pose a potential risk to human health or the environment; however, it identified 18 IR sites where soil posed a potential unacceptable risk to potential receptors. The initial FS was conducted concurrently with the RI, and the draft final FS report for Parcel D was submitted to the regulatory agencies in 1997 (PRC and LFR 1997). The proposed remediation plan for Parcel D was completed and distributed in May 1997, followed by a 30-day public comment period that ended in June 1997. Based on the comments received during the public review period and on concerns from the regulatory agencies, the Navy decided to conduct interim removal actions (see Section 2.4) to reduce areas of contaminated soil, while further evaluating the soil data at Parcel D. At the same time, the Navy agreed to assess further groundwater at Parcel D as requested by the regulatory agencies.

The regulatory agencies' comments on the draft final RI report and the draft final FS report did not concur with the conclusion that groundwater at Parcel D does not pose a risk to human health and the environment; therefore, the Navy decided to further evaluate these risks in a revised FS.

The draft revised FS for Parcel D was submitted to the regulators in 2002. The Navy evaluated groundwater at Parcel D in the draft revised FS for (1) risks to human health through the drinking water pathway, (2) risks to human health through inhalation of volatile organic compounds (VOC) in indoor air from the shallowest groundwater zone, (3) risks to human health through consumption of aquatic life from the Bay that could be affected by the groundwater, and (4) ecological risk. Based on the exemption criteria in the California State Water Resource Control Board's (SWRCB) Sources of Drinking Water Resolution 88-63 (SWRCB 1988), the Navy concluded in the draft revised FS that the shallow A-aquifer at HPS did not have a beneficial use to future residents; therefore, the ingestion pathway from this water bearing zone was considered incomplete. In addition, the Navy evaluated the B-aquifer as a potential source of domestic water use to future residents at the site in the draft revised FS.

In September 2003, the Water Board concurred that the A-aquifer groundwater beneath HPS is not a potential source of drinking water pursuant to SWRCB Resolution 88-63 and Water Board Resolution 89-39 (Water Board 2003). In October 2004, and in February 2005, the BCT met and agreed to a revised HHRA methodology for both soil and groundwater. For soil, the BCT agreed that the HHRA would be comprised of six scenarios representing total risk and six scenarios with representing incremental risk, which excludes metals with maximum concentrations detected at Parcel D below the Hunters Point ambient levels (HPAL) (PRC 1995). For groundwater, the BCT agreed to a revised HHRA methodology for groundwater incorporating the 12 most recent rounds of groundwater data for each analyte. As a result of agency comments and agreements made between members of the BCT since the draft revised FS report was submitted in 2002, this final revised FS report presents (1) an updated evaluation for federal criteria for both the A– and the B–aquifers, (2) a revised HHRA for both soil and groundwater using the appropriate exposure scenarios in accordance with planned reuses and beneficial uses of groundwater, (3) an evaluation of potential surface water quality of the Bay due to chemicals in groundwater, and (4) an updated development and evaluation of remedial alternatives. In addition, site characterization data that reflect results of completed removal actions and ongoing groundwater monitoring at Parcel D since 2002 are also provided in this FS report.

This revised FS report addresses CERCLA regulated chemicals. Potential radiological contamination will be addressed in a radiological addendum to this revised FS. Both chemical and radiological contaminants will then be addressed together in the proposed plan and the ROD.

1.2 PURPOSE AND ORGANIZATION OF THIS REVISED FS REPORT FOR PARCEL D

The purpose of this final revised FS report for Parcel D is to update the data and site characterization information available since the 1997 FS, including refining the site conceptual model; reevaluate the risks posed by contaminants in soil and groundwater at Parcel D using the updated data prior to July 2004 and the revised methodology; refine the RAOs to be consistent with the Conveyance Agreement signed in March 2004 (Navy and San Francisco Redevelopment Agency 2004); and reevaluate remedial alternatives applicable at Parcel D. The BCT will use this revised FS report to assist in evaluating the appropriate remedial actions for Parcel D to allow transfer of the property to the City and County of San Francisco.

This report was prepared in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and EPA guidance, "Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA" (EPA 1988). The NCP states that remediation should be accomplished through the use of cost-effective remedial alternatives that effectively lessen threats to and provide adequate protection of public health, welfare, and the environment (EPA 1990a). Remedial alternatives that are protective of human health and the environment are evaluated in this final revised FS report.

During the FS process, remedial alternatives are developed by assembling media-specific technologies into cleanup alternatives. The process consists of the following general steps:

- Develop RAOs that specify the contaminants and media of interest, exposure pathways, and remediation goals that permit a range of treatment and containment alternatives to be developed. RAOs are developed on the basis of chemical-specific applicable or relevant and appropriate requirements (ARAR), the HHRA results, and metals that pose potential ecological impacts to the Bay.

- Develop general response actions (GRA) for each media that define containment, removal, treatment, disposal, or other actions, singularly or in combination that can be implemented to satisfy the RAOs.

- Identify volumes or areas to which GRAs apply.

- Identify and screen remedial technologies for each GRA to eliminate technologies that cannot be implemented, technically or cost effectively, at the site. GRAs specify types of remedial technologies. For example, the GRA for a treatment can include chemical or biological technology types.

- Identify and screen process options for each remedial technology. For example, chemical oxidation and dechlorination are under the process option chemical treatment.

- Assemble process options into alternatives, screen the alternatives, and evaluate the retained alternatives.

The information in this final revised FS report is organized into seven sections. After this introduction, the remaining six sections present updated site characterization and risk assessment and the results of the FS process for Parcel D, as summarized below.

- **Section 2.0 – Hunters Point Shipyard and Parcel D Site History and Characterization** describes the current soil and groundwater conditions at Parcel D. Data presented includes RI data, interim removal action data, and additional groundwater investigation and monitoring data collected since the 1997 FS report and prior to July 2004. The site characterization update presents the nature and extent of the chemicals of concern (COC) identified in soil and groundwater based on the revised HHRA and environmental evaluation for Parcel D.

- **Section 3.0 – Risk Evaluation Summary and Remediation Goals** presents a summary of the human health risks based on the soil and groundwater conditions and planned future land uses and the evaluation of potential threats to the Bay from chemicals detected in groundwater. Remediation goals are then presented for the COCs identified from the HHRA, and trigger levels for those COCs in groundwater that pose a potential risk to the Bay.

- **Section 4.0 – Remedial Action Objectives, General Response Actions, and Process Options** presents RAOs and ARARs for Parcel D based on the site characterization, HHRA results, and the environmental evaluation. GRAs are then identified that address the RAOs and ARARs. Process options associated with each GRA are then screened for their technical and economic implementability.

- **Section 5.0 – Development and Description of Remedial Alternatives** presents a detailed description of the remedial alternatives based on the selected process options in Section 4.0 that will satisfy the RAOs. Process options recommended for consideration are assembled, singularly or in combination, to create remedial alternatives.

- **Section 6.0 – Detailed Analysis of Remedial Alternatives** presents the evaluation of each remedial alternative developed in Section 5.0 against EPA's nine evaluation criteria. The alternatives are then compared against each other to evaluate their relative advantages and disadvantages with respect to the nine evaluation criteria.

- **Section 7.0 – References** presents a list of documents and support material used to generate this report.

In addition, supporting data, calculations, and evaluations for this final revised FS report appear in the appendices as:

- **Appendix A– Analytical Results for Soil and Groundwater at Parcel D,** presents all Parcel D soil and groundwater data used in this FS report.

- **Appendix B– Parcel D Human Health Risk Assessment,** presents a detailed description of the risk methodology and results, including figures and tables for the various exposure scenarios. Section 3.1 summarizes Appendix B.

- **Appendix C– Applicable or Relevant and Appropriate Requirements** identifies and evaluates potential federal and State of California ARARs, and presents the Navy's determinations regarding these ARARs' applicability to the alternatives in this FS. The ARARs are summarized in Section 4.2.

- **Appendix D– Groundwater Beneficial Use Evaluation,** presents a detailed analysis of the beneficial use of the A-aquifer and the B-aquifer at Parcel D, to help define the appropriate exposure scenarios in the HHRA. Section 2.2.9 summarizes the beneficial use determinations for Parcel D.

- **Appendix E– Conceptual Groundwater Monitoring Approach and Exit Strategies,** presents the basis for and the proposed groundwater monitoring at Parcel D in support of the groundwater alternatives presented in this FS report. The proposed monitoring approach is used as the basis for estimating costs associated with a potential future remedial action monitoring plan.

- **Appendix F– Remedial Alternative Costs Summary,** presents detailed costs and associated assumptions for each alternative that were used to support the evaluation of the cost criterion in Section 6.0. Appendix F includes detailed spreadsheets that provide per unit costs and quantities for each line item.

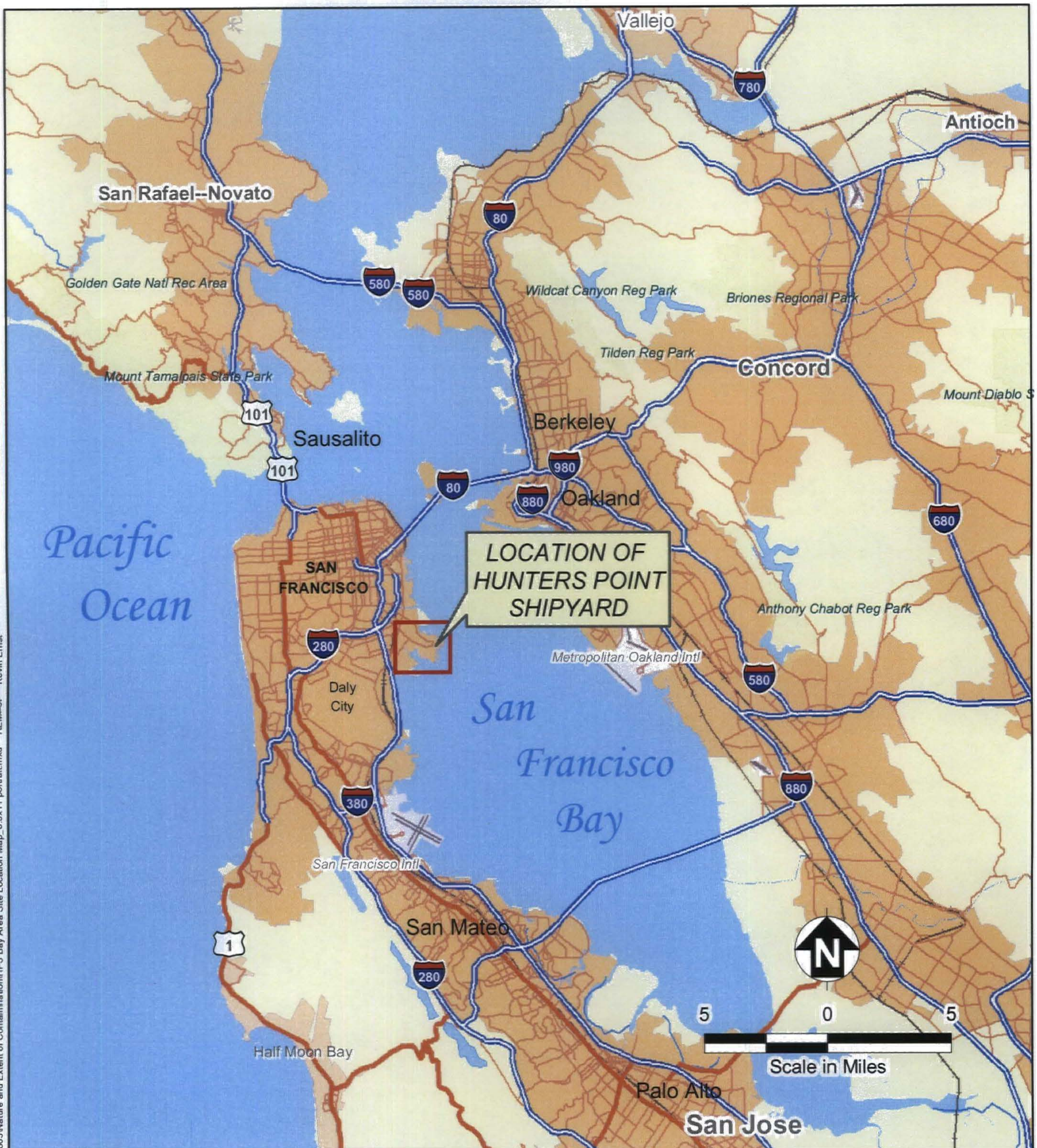
- **Appendix G – Groundwater Modeling and Calculation of Attenuation Factors,** summarizes the results of groundwater modeling for several areas at Parcel D of HPS with plume concentrations above their applicable surface water criteria.

- **Appendix H – Preliminary Screening of Groundwater Impacts to San Francisco Bay,** provides a comparison of groundwater concentrations at Parcel D with appropriate surface water quality criteria.

- **Appendix I – Trigger Levels for Groundwater Impacts to San Francisco Bay,** presents the applicable toxicological and physicochemical factors relevant to developing trigger levels for Plumes in Parcel D groundwater.

- **Appendix J – Responses to Regulatory Agency Comments on the Draft and Draft Final Parcel D Feasibility Study,** presents the Navy's responses to comments received from local, state, and federal agencies on the draft revised FS report submitted in 2002 and on the draft final revised FS report submitted in July 2007.

FIGURES



Location Map

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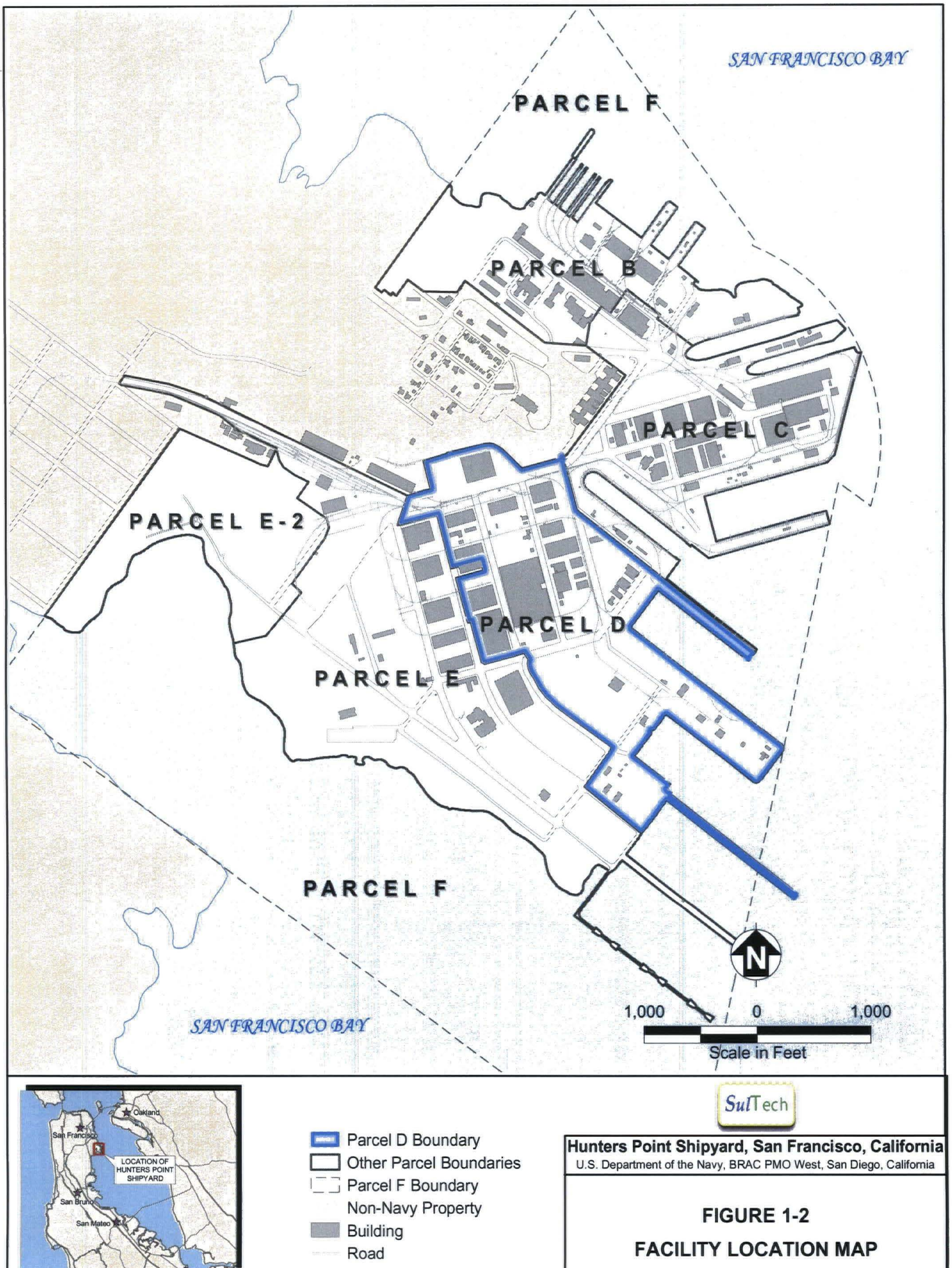
Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 1-1

HUNTERS POINT LOCATION MAP

Revised Feasibility Study Report for Parcel D

2007-10-15 ...\Hunters_Point\Projects\Parcel_DIFS_2005\Nature and Extent of Contamination\HPS Bay Area Site Location Map_8.5x11 portrait.mxd TIE... Kevin Ernst



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Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 1-2

FACILITY LOCATION MAP

Revised Feasibility Study Report for Parcel D

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2.0 HUNTERS POINT SHIPYARD AND PARCEL D SITE HISTORY AND CHARACTERIZATION

The Navy acquired HPS in 1939. The main portion of HPS is situated on a long promontory in the southeastern part of San Francisco, extending eastward into the Bay (see Figure 1-1). The property at HPS consists of 866 acres, 420 on land, and 446 off shore.

Parcel D was originally 128 acres in the southeast-central portion of HPS and consisted of 27 IR sites that were investigated during the initial RI. In 1997, IR-36 was transferred from Parcel D to Parcel E, reducing the area of Parcel D to 101 acres. In March 2004, a portion of Parcel A was transferred to Parcel D. In February 2005, the Navy redefined the boundary of Parcel D to exclude sites IR-08, IR-38, and IR-39, reducing Parcel D by an additional 3 acres to its current 98 acres (see Figure 2-1).

Parcel D currently contains all or portions of 23 IR sites. Twenty IR sites are located entirely within Parcel D: IR-09, IR-16, IR-17, IR-22, IR-32, IR-33 North and South, IR-34, IR-35, IR-37, IR-44, IR-48, IR-53, IR-55, IR-65, IR-66, IR-67, IR-68, IR-69, IR-70, and IR-71. Portions of sites IR-45 (steam line system) and IR-50 (storm drain and sanitary sewer system) are also within Parcel D because they are facility-wide utility sites that traverse several parcels. Site IR-51 is also a facility-wide site that consists of buildings and areas that formerly housed electrical transformers, including locations within Parcel D.

This section presents information on the site history and characterization of HPS and Parcel D that is relevant to the evaluation in the FS. Section 2.1 discusses the history of HPS. Section 2.2 discusses the setting of HPS and Parcel D, including land use, historic areas, climate, topography and surface water drainage, ecology, soils, geology, and hydrogeology. Section 2.3 summarizes past investigations, and Section 2.4 summarizes removal actions completed at Parcel D. Section 2.5 presents the nature and extent of the environmental chemicals of interest in soil and groundwater at Parcel D.

2.1 HPS HISTORY

The promontory where HPS is located has been recorded in maritime history since 1776, first as Spanish mission lands used for cattle grazing, and later as a dry dock in the 1840s. In 1939, the U.S. government received title to the land at Hunters Point and began developing it as a shipyard. Originally a deepwater, two dry dock facility when it was purchased, the Navy augmented HPS to a full-service ship repair and maintenance facility with numerous support buildings, an internal railroad, and living quarters. To support the expansion, the Navy quarried the nearby cliffs to create a working pad 12 to 15 feet above mean sea level by filling the Bay with quarried material (Navy 2004). The filled areas were supported by concrete seawalls along the waterfront. From 1945 to 1974, the Navy used HPS predominantly as a repair facility. Additional acreage, mostly on the south side of the base, was acquired in 1957. The Navy operated the shipyard as a ship repair facility through the late 1960s. HPS was also the site of the Naval Radiological Defense Laboratory.

In 1974, the Navy ceased shipyard operations at HPS and transferred control of the property to its Office of the Supervisor of Shipbuilding, Conversion, and Repair in San Francisco. The shipyard remained relatively unused until 1976. From 1976 to 1986, the Navy leased 98 percent of HPS to a private ship repair company, Triple A Machine Shop, Inc. (Triple A). Triple A leased the property from July 1, 1976, through June 30, 1986; however, Triple A did not vacate the property until March 1987. During the lease period, Triple A used dry docks, berths, machine shops, power plants, offices, and warehouses to repair commercial and naval vessels. Triple A also subleased portions of the property to other businesses.

In 1987, the Navy resumed occupancy of HPS. Many of the subtenants under Triple A's lease remained as Navy tenants, including those using facilities for maritime, industrial, and artistic purposes. From November 1985 to August 1989, several Navy surface ships were docked at the shipyard.

Because hazardous materials from past shipyard operations had been released into the environment, HPS was included on the National Priorities List in 1989 as a Superfund site pursuant to CERCLA as amended by the Superfund Amendments and Reauthorization Act of 1986. In 1991, HPS was slated for closure under the Defense Base Closure and Realignment Act of 1990. HPS was designated as a "B" site by the Agency for Toxic Substances and Disease Registry (ATSDR) in 1991, which meant that ATSDR determined that HPS posed no imminent threats to human health but had the potential to pose long-term threats to human health (ATSDR 1991). On April 1, 1994, the HPS mission as a shipyard officially ended under the Defense Base Closure and Realignment Act of 1990.

The Naval Facilities Engineering Command, Engineering Field Activities West, in San Bruno, California, had initial oversight of the base closure management. After closure of Engineering Field Activity West in 2000, the oversight authority was transferred to the Naval Facilities Engineering Command, Southwest Division, in San Diego, California. Ongoing work at HPS is currently overseen by BRAC Program Management Office West, in San Diego, California.

2.2 HPS AND PARCEL D SETTING

The following subsections summarize the setting of HPS and Parcel D, including (1) land use, (2) historic areas, (3) climate, (4) topography and surface water drainage, (5) ecology, (6) soils, (7) geology, (8) hydrogeology, and (9) groundwater beneficial use. A detailed description of the HPS setting is presented in Section 3.0 of the draft final Parcel D RI report (PRC, LFR, and U&A 1996). Detailed updates on the geology and hydrogeology of Parcel D are also provided in the Phase II and III groundwater data gaps investigation (GDGI) reports (Tetra Tech EM Inc. [Tetra Tech] 2001b, 2003a).

2.2.1 HPS, Surrounding Area, and Parcel D Land Use

The Bayview/Hunters Point district of San Francisco bounds the HPS promontory on the north and west, and the Bay borders HPS on the south and east. The Bayview/Hunters Point district is a low-density demographic area where about half the residents own their homes. More than half of the land in the San Francisco Bayview/Hunters Point district is used for industrial purposes.

The land at HPS was formerly divided into three distinct functional areas: (1) the industrial production area, which consisted of the waterfront and shop facilities for the structural machinery, electrical, and HPS service groups; (2) the industrial support area, which consisted of supply and public works facilities; and (3) the nonindustrial area, which consists of former residential facilities for Navy personnel, recreational areas, and a restaurant.

Parcel D is bounded by other portions of HPS and by the Bay. Most land at Parcel D was formerly part of the industrial support area and was used for shipping, ship repair, and office and commercial activities. Portions of Parcel D were also used by the Naval Radiological Defense Laboratory (NRDL). The docks at Parcel D were formerly part of the industrial production area. The historical and current uses of buildings at Parcel D are summarized in Table 2-1. This table also includes the radiological contamination potential at these buildings or building sites, as listed in the Historical Radiological Assessment (Radiological Affairs Support Office [RASO] 2004). According to the Redevelopment Plan (San Francisco Redevelopment Agency 1997), Parcel D will be zoned for the following reuses: educational and cultural, mixed uses, research and development, open space, industrial, and maritime industrial. The proposed reuse areas are shown on Figure ES-1.

2.2.2 Parcel D Historic Areas

The 450-ton bridge crane at the Regunning Pier (IR-32) is the only structure in Parcel D with the potential for inclusion on the National Register of Historic Places (PRC, LFR, and U&A 1996). As a result, any proposed remedial action performed at IR-32 will comply with the substantive requirements of the National Historic Preservation Act.

2.2.3 Parcel D Climate

The climate in the HPS area is characterized by partly cloudy, cool summers with little precipitation and mostly clear, mild winters with moderate precipitation. The prevailing wind direction is west to east (Brown and Caldwell 1995). The average wind speed is 10 miles per hour, and the usual maximum wind speed is 20 miles per hour. Normal annual rainfall in San Francisco, as monitored at the San Francisco Federal Building, is 20 inches (National Oceanic and Atmospheric Administration [NOAA] 2005).

2.2.4 Parcel D Topography and Surface Water Drainage

More than 80 percent of HPS consists of relatively level lowlands, which was mostly constructed by placing borrowed fill material from the surrounding hills along the margin of the Bay. Nearly 100 percent of Parcel D is located in the lowlands, with surface elevations between 0 to 10 feet above mean sea level. Figure 2-2 shows ground surface elevation contours for Parcel D.

Storm water surface runoff at HPS drains primarily in a sheet-flow pattern from the highlands north and west of Parcel D to the surrounding lowlands. Runoff in Parcel D is collected by the storm drain system and discharged through outfalls to the Bay. The storm drain system at HPS consists of 10 major drainage areas. Five of these storm water drainage areas are located completely or partially within Parcel D. In addition, eight smaller isolated drainage areas are located in Parcel D, each with an independent outfall (PRC, LFR, and U&A 1996). Approximately 10 percent of the HPS surface is not served by the storm drain system, including the undeveloped shoreline, some pier areas, and a trailer parking lot. No naturally occurring drainage channels remain at HPS. Pre-existing drainage channels were filled in or modified by construction over the years. The location and distribution of the storm drain and sanitary sewer lines at Parcel D are presented on Figure 2-3. The Navy has begun to remove the storm drain and sanitary sewer lines throughout Parcel D; completion is planned for 2008.

2.2.5 Parcel D Ecology

Several hundred types of plants and animals are believed to live at or near HPS, including terrestrial and marine plants and algae; benthic and water column-dwelling marine animals such as clams, mussels, amphipods, and fish; insects; amphibians; reptiles; birds; and mammals. No threatened or endangered species are known to inhabit HPS or its vicinity (Environmental Science Associates 1987). Parcel D ecology is limited to those plant and animal species adapted to the industrial environment. For example, the 450-ton bridge crane could provide nesting locations for peregrine falcons, which would also prey on smaller birds (RASO 2004). Viable terrestrial habitat is inhibited at Parcel D because approximately 85 percent of the ground surface is covered by pavement and industrial buildings. Physical structures at Parcel D, such as docks and piers, may serve as artificial habitats for estuarine life.

In the spring of 2004, an individual burrowing owl (*Athene cunicularia*) was sighted at Parcel D. Burrowing owls are listed as "Species of Special Concern" by the California Department of Fish and Game (2004). Species of special concern status applies to animals not listed under the federal or state Endangered Species Act, but which nonetheless are declining at a rate that could result in listing, or have historically occurred in low numbers and known threats to their persistence currently exist.

The burrowing owl was identified prior to implementing a time-critical removal action (TCRA) for removing stockpiled soil at Parcel D (see Section 2.4). The owl's burrow was observed on the ground in the area of the soil stockpiles and was not within the stockpiled soil. Appropriate measures were taken during the field activities for the TCRA to minimize the impacts to the burrowing owl's habitat (Tetra Tech 2004; Navy 2004).

In March 2005, the Navy surveyed Parcel D and determined that a burrowing owl was present at the site. The Navy decided that the burrowing owl would be relocated because excavation and removals were planned for the summer of 2005 at the adjacent Parcel E and because future remediation of Parcel D could include remedies that potentially could affect the owl.

As a result, in April 2005, the owl was relocated off Parcel D using a passive relocation method. Passive relocation involves installing a one-way door in the burrows, so that the owl can leave but not reenter, and collapsing the burrows 48 hours after the door is in place. The Navy consulted with Peter Bloom of the California Department of Fish and Game to conduct this passive relocation project in accordance with California Department of Fish and Game guidelines.

No other potential terrestrial receptors or habitat have been identified at Parcel D. It is unlikely that Parcel D will contain terrestrial habitat in the future because its proposed reuse is primarily industrial.

2.2.6 Parcel D Soils

Soils at HPS are either the result of (1) weathered material from nearby rock formations and sediments from the Bay or (2) imported fill material placed at HPS during its development. The area northwest of Parcel D is primarily covered by upland soils, which are moderate to steeply sloped terrains. Parcel D is primarily lowland soils, which are flat to gently sloped urban developed lands. These lowland soils are susceptible to subsidence by natural compaction or during moderate to strong earthquakes. Soils at HPS are described in detail in Appendix H of the draft final Parcel D RI report (PRC, LFR, and U&A 1996). Figure 2-4 shows the distribution of soils at HPS.

2.2.7 Parcel D Geology

The peninsula forming HPS is within a northwest-trending belt of Franciscan Complex bedrock known as the Hunters Point Shear Zone. In some locations, the Marin Headlands Terrane underlies this shear zone. HPS is underlain by five geologic units, the youngest of Quaternary age, and the oldest, the Franciscan Complex bedrock, of Jurassic-Cretaceous age. In general, the stratigraphic sequence of these geologic units, from youngest (shallowest) to oldest (deepest), is as follows: Artificial Fill; Undifferentiated Upper Sand Deposits; Bay Mud Deposits; Undifferentiated Sedimentary Deposits; and Franciscan Complex Bedrock. The locations of the fill material, the colluvium, alluvium and landslide debris, and the chert, shale, sandstone, volcanic, and serpentine bedrock units at HPS are shown on Figure 2-5.

The Navy believes that the practice of using quarried local rock for fill at HPS is similar to construction practices in the same bedrock formations used elsewhere in San Francisco. The Navy observed that a wide range of concentrations of metals are found in similar chert, basalt, and serpentinite bedrock formations in other areas of San Francisco based on sampling that the Navy conducted in 2003 at areas outside of HPS. This information is summarized in a report titled “Draft Metals Concentrations in Franciscan Bedrock Outcrops” (Tetra Tech and Innovative Technical Solutions, Inc. [ITSI] 2004).

In the Tetra Tech and ITSI 2004 report, the Navy studied the ambient concentrations of metals in bedrock and bedrock-derived soil from three nonindustrial sites in San Francisco. These three sites have a similar geologic setting to HPS and contain serpentinite or chert and basalt bedrock typical of the Franciscan Complex. The sites included the two Franciscan Complex subunits that form the HPS peninsula: the Hunters Point Shear Zone and the Marin Headlands Terrane. The investigation included about 30 rock and soil samples from each of the three sites (91 samples total) that were analyzed for metals using a standard analytical suite of EPA methods. The study found elevated concentrations of arsenic, iron, and manganese associated with chert bedrock and elevated nickel concentrations associated with serpentinite. The chemical composition of soil at the three sites was found to be similar to the chemical composition of rock. Of the 91 samples collected, none met the cleanup standards for unrestricted residential reuse at HPS because of the elevated ambient concentrations of these metals in the serpentinite bedrock and its derived soils. Based on this study, the Navy believes that the elevated concentrations of metals in the soils at HPS as represented by the HPALs, is also a result of the ambient metals concentrations in a serpentinite sourced fill material.

The draft final Parcel D RI report presented cross sections (see Figures 3.7-10 through 3.7-15 of that report) that depict the relationship of the various geologic units at the site (PRC, LFR, and U&A 1996). The geologic interpretations presented in the cross sections were updated in the 2002 draft Parcel D revised D FS based on data collected during the Phases I and II GDGI (Tetra Tech 2001a, 2001b). The cross section location map and the updated cross sections are presented on Figures 2-6 and 2-7.

The following description of the geologic setting at Parcel D summarizes the information presented on the updated cross sections. The bedrock at Parcel D is mainly composed of serpentinite belonging to the Hunters Point Shear Zone of the Franciscan Complex (Tetra Tech 2001b). The depth to Franciscan Complex Bedrock from the ground surface in Parcel D varies from less than 1 foot in the northern area to more than 120 feet in the southeastern area. Undifferentiated Sedimentary Deposits overlie bedrock over much of Parcel D, occurring beneath Bay Mud Deposits or, rarely, directly beneath Artificial Fill; these deposits range up to 80 feet thick. Bay Mud Deposits underlie most (about 80 percent) of Parcel D, except for a strip along the northern margin of the site. Where present, Bay Mud Deposits are typically 20 to 30 feet thick and are thickest (up to 40 feet) beneath the southeastern part of the parcel. Undifferentiated Upper Sand Deposits are discontinuous beneath Parcel D. These deposits generally overlie Bay Mud, but may interfinger with Bay Mud Deposits and, in a few localities, directly overlie Undifferentiated Sedimentary Deposits. The Undifferentiated Upper Sand Deposits generally range from a few feet to up to 40 feet thick. Artificial Fill overlies all of the naturally occurring units and ranges from approximately 2 feet thick in the north to 40 feet thick in the middle of Parcel D. In most of Parcel D, the artificial fill ranges from 20 to 30 feet thick. The thickness of the Artificial Fill and all sedimentary deposits generally increases toward the Bay. Table 2-2 summarizes the geology at each IR site located within Parcel D.

2.2.8 Parcel D Hydrogeology

This section summarizes the hydrostratigraphic units, groundwater flow patterns, and hydraulic characteristics of the main hydrogeologic units. Detailed descriptions of the hydrogeology at Parcel D are presented in the RI (PRC, LFR, and U&A 1996; PRC and LFR 1997) and Phase II and III GDGI reports (Tetra Tech 2001b, 2003a).

2.2.8.1 Hydrostratigraphic Units

The hydrostratigraphic units at HPS are (1) the A-aquifer, (2) the aquitard, (3) the B-aquifer, and (4) the deep bedrock water-bearing zone. Cross sections presented on Figure 2-7 show the hydrostratigraphic units in different colors, except for the deep (fractured) bedrock water-bearing zone, which is shown in white. The shallow (weathered) bedrock water-bearing zone near the boundary between the non-Navy property to the north and Parcel D (shown on the left side of cross section A-A' on Figure 2-7) and at other locations is hydraulically connected with the A-aquifer and therefore is considered part of the A-aquifer in this location.

Shallow, unconfined groundwater occurs continuously across all of Parcel D in the A-aquifer. The A-aquifer at Parcel D consists mainly of unconsolidated artificial fill material that overlies the aquitard and bedrock. Undifferentiated Upper Sand is also part of the A-aquifer at some locations. Based on the cross sections shown on Figure 2-7, the A-aquifer consists mostly of sandy gravel and gravelly sand with limited zones of low-permeability sandy clay. Significant portions of the A-aquifer are also made up of less permeable fill. The A-aquifer typically ranges from 10 to 40 feet thick, but averages approximately 25 feet thick.

The aquitard is generally made up of silts and clays of the Bay Mud and Undifferentiated Sedimentary deposits. The aquitard ranges from 0 to 100 feet thick, but is most commonly 40 to 80 feet thick (see Figure 2-7). The aquitard is absent in the northern part of Parcel D where the A-aquifer is in direct contact with the bedrock and is thickest in the southeastern part of the parcel. The aquitard inhibits groundwater communication between the A-aquifer and the B-aquifer.

The B-aquifer is associated with the Undifferentiated Sedimentary deposits and consists of small, laterally discontinuous permeable sediment lenses of gravel, sand, silty sand, or clayey sand intermingled with the aquitard. The largest B-aquifer area is present near the center of Parcel D. The B-aquifer area at this location is estimated to be approximately 1,500 feet wide by 1,000 feet long, and is shown at its appropriate depth in cross sections A-A' and C-C' (see Figure 2-7). The B-aquifer varies from 20 to 30 feet thick. Groundwater in the discontinuous B-aquifer areas is under confined conditions. Table 2-2 summarizes the hydrogeologic units underlying each IR site.

2.2.8.2 Groundwater Flow Patterns and Tidal Effects

More than 85 percent of the ground surface at Parcel D is covered by pavement and buildings; as a result, most precipitation is channeled into the storm drain system. Unpaved areas may serve as localized vertical recharge areas. Leaking water lines also serve as limited sources of localized recharge. Base flow from the uplands north of Parcel D provides lateral groundwater recharge across the northern boundary of the parcel. Groundwater discharges directly to the Bay (1) along the shoreline, which is significantly modified by the presence of impermeable dry docks and sea walls in some areas, and (2) through permeable or semipermeable utility line corridors. In the past, groundwater that entered the sanitary sewer was discharged to the local publicly owned treatment works. Currently, the sanitary sewer system has been disconnected, and the sanitary sewers are being removed as part of a radiological removal action.

Groundwater flow patterns at Parcel D are complex because they are affected by (1) a groundwater sink located near the former western boundary of Parcel D (this area is now in Parcel E); (2) a groundwater mound located near the current western boundary of Parcel D (beneath IR-33, IR-44, IR-66, and IR-67); (3) leaks of groundwater into former sanitary sewers or storm drains; (4) recharge from water supply lines; and (5) tides in the Bay. Most groundwater at Parcel D flows toward the Bay, except in the western portion of Parcel D, which historically has flowed away from the mound and toward the groundwater sink in Parcel E (see Figure 2-8), where groundwater elevations are below mean sea level. The sink is believed to be caused by leaks of groundwater into sanitary sewer lines, which was then pumped off site to the local publicly owned treatment works, thereby lowering groundwater levels in the area. Flow patterns are anticipated to change as the sewer and storm drain lines are removed. Figure 2-9 shows the groundwater elevation contours from groundwater monitoring in March 2007.

The investigation of the bedrock underlying Parcel D has been limited and included areas where shallow bedrock and colluvium are hydraulically connected to the A-aquifer. In addition, the deep borings at Parcel D indicate the deeper bedrock underlying the Undifferentiated Sedimentary deposits consists mostly of fractured and moderately to strongly weathered serpentinite. Direct vertical hydraulic communication between the A-aquifer and the B-aquifer is inhibited because of the thick aquitard that separates them (see Figure 2-7). In addition, an upward vertical hydraulic gradient was observed at most well pairs installed at Parcel D (Tetra Tech 2004). Therefore, at Parcel D, migration of groundwater from the A-aquifer to the B-aquifer is considered minimal.

Tidal influence is the periodic fluctuation in the elevation of the groundwater table with time, caused by tide fluctuations in the Bay. Tidal influence may also include mixing or diluting groundwater with bay water, but the mixing usually does not occur as far inland as the fluctuations in groundwater elevation. The tidal influence zone is defined as the area where the maximum tidal fluctuation (difference in groundwater elevation between consecutive high and low tides) exceeds 0.10 foot. Based on tidal influence studies conducted during the RI (PRC, LFR, and U&A 1996) and the phase III GDGI (Tetra Tech 2003a), the tidal influence zone extends inland up to about 500 feet. Storm drains and utility corridors that are submerged below the water table could locally increase the magnitude of the tidal influence and the distance inland that is affected. Figure 2-3 shows the storm and sanitary sewer utility lines that are below the water table. The storm and sanitary sewer utility lines at Parcel D are scheduled for removal during 2007 and 2008.

2.2.8.3 Hydraulic Characteristics

The hydraulic conductivity of the A-aquifer at Parcel D typically ranges from 1 to 21 feet per day. The hydraulic conductivity was estimated based on data from slug and pumping tests performed during the RI (PRC, LFR, and U&A 1996). The minimum and maximum reported hydraulic conductivity values for IR sites located within Parcel D are 0.025 and 580 feet per day. The wide range of reported hydraulic conductivities indicates that the aquifer matrix is very heterogeneous. The A-aquifer consists primarily of heterogeneous artificial fill materials that vary from clay to silt to sand to gravel.

The estimated groundwater velocities at Parcel D range from 1.5 to 31 feet per year. These velocities were calculated using the typical intermediate value of hydraulic gradient for the A-aquifer throughout Parcel D of 0.001 (PRC, LFR, and U&A 1996) and an assumed effective porosity for the A-aquifer of 0.25. No slug test or pumping test evaluations were performed for the B-aquifer within Parcel D. However, slug tests were performed in two monitoring wells in the underlying fractured bedrock water-bearing zone at IR-09 in the north-central area of Parcel D (PRC, LFR, and U&A 1996), with estimated hydraulic conductivities ranging from 0.025 to 3.7 feet per day. In general, groundwater velocities in the fractured bedrock water-bearing zone is expected to be low because the flow occurs mostly through fractures that are likely filled with residual clays and silts (PRC, LFR, and U&A 1996).

2.2.9 Groundwater Beneficial Use Evaluation

This section summarizes the beneficial use evaluation conducted for groundwater underlying Parcel D. The complete beneficial use evaluation is presented in Appendix D. The potential beneficial uses of Parcel D groundwater have been evaluated several times in the past (see Appendix D; Tetra Tech 2001c). In 2003, the Navy concluded that A-aquifer groundwater at Parcel D is unsuitable for use as a potential source of drinking water based on an evaluation of site-specific factors (Navy 2003). In 2003, the Water Board concurred with the Navy's determination that the A-aquifer at HPS is not a potential drinking water source (Water Board 2003). EPA, however, did not concur and required that federal criteria also be used to assess if Parcel D groundwater could be considered a potential drinking water source.

EPA considers groundwater to be a potential source of drinking water if the following criteria are met:

- The total dissolved solids (TDS) concentration is less than 10,000 milligrams per liter (mg/L)
- A minimum well yield of 150 gallons per day or 0.104 gallon per minute can be achieved

Figure 2-10 presents the maximum TDS concentrations detected in A-aquifer groundwater monitoring wells at Parcel D. As shown on Figure 2-10, TDS concentrations exceed 10,000 mg/L along the Parcel D shoreline and are less than 10,000 mg/L in the central and northwestern part of the parcel. The federal TDS criterion was applied separately to each IR site at Parcel D in this FS report. Based on this criterion, groundwater underlying all or part of the following 17 IR sites could be considered potential sources of drinking water: IR-09, IR-16, IR-17, IR-32, IR-33 North and South, IR-34, IR-37, IR-44, IR-48, IR-53, IR-55, IR-65, IR-66, IR-67, IR-68, IR-69, and IR-70. Based on known hydrogeologic conditions at Parcel D, it is assumed that a minimum well yield of 150 gallons per day could also be achieved from

A-aquifer wells at these IR sites (PRC, LFR, and U&A 1996). A-aquifer groundwater in these areas was further evaluated against the site-specific factors below.

In a 1999 letter, EPA provided the Navy with additional guidelines for applying the federal criteria (EPA 1999a). An attachment to the letter (referred to as "Enclosure 5") listed site-specific factors that can be considered in deciding whether all or portions of an aquifer should be considered a potential source of drinking water. This letter is provided as an attachment to Appendix D. These factors include the following: (1) aquifer thickness, (2) TDS levels measured, (3) groundwater yield, (4) proximity to saltwater and the potential for saltwater intrusion, (5) the quality of underlying water-bearing units, (6) the existence of institutional controls on well construction or aquifer use, (7) information on current and historical use of the aquifer on the base or in the community surrounding the base, and (8) the cost of cleanup to federal drinking water standards. In addition, the BCT considered depth to groundwater a relevant site-specific factor because shallow aquifers are susceptible to contamination and may not be suitable sources of drinking water as a result.

The Navy evaluated seven of the eight factors listed above. Not included was factor number five, the quality of underlying water-bearing units. Quality of underlying water-bearing units was not considered because the B-aquifer at Parcel D is isolated and limited, and the deep bedrock water-bearing zone at Parcel D was not identified or investigated.

Table 2-3 summarizes the results of each of the eight site-specific factor evaluations and the overall potential for the A-aquifer to be used as a source of drinking water in each of the IR sites that meet the federal TDS criterion. The Navy believes that the A-aquifer underlying each of these sites has no potential to be used as a source of drinking water, based on the eight evaluation factors in Table 2-3, and on the key criteria presented below.

- **Aquifer thickness and depth to groundwater:** Generally, the depth to groundwater for the A-aquifer is less than 10 feet across Parcel D. The average thickness of the A-aquifer is approximately 25 feet, with a maximum thickness of approximately 40 feet (see Figure 2-7). Together, these two site-specific factors indicate the A-aquifer at Parcel D is very shallow and of limited extent, and therefore may not be suitable as a potential source of drinking water.

- **Existence of institutional controls on well construction or aquifer use:** California Department of Water Resources Bulletins 74-81 and 74-90 provide standards for well construction in California (Department of Water Resources 1981, 1991). These bulletins indicate that an individual domestic well must have a minimum seal of at least 20 feet from the ground surface, and a community water supply well must have a minimum seal of at least 50 feet from the surface for the wells to be used for water supply. Wells installed in the A-aquifer would not meet the minimum well seal requirements because of the shallow depth to groundwater at Parcel D (less than 10 feet). These well construction standards also prohibit installation of domestic wells within 50 feet of a storm drain or sanitary sewer line. Figure 2-11 shows areas of Parcel D that are beyond 50 feet of a sewer line and meet the TDS requirements.

As shown on Figure 2-11, most of Parcel D is within the 50-foot buffer zone from the sewer lines. Although these lines will be removed by the Navy, this figure shows the likely density of sewer lines that would be installed by the City and County of San Francisco during redevelopment of HPS. As a result, installation of domestic wells would be prohibited in many portions of the A-aquifer at Parcel D. Also, the City and County of San Francisco regulations prohibit installation of domestic wells within city boundaries. Based on the existence of these local and state institutional controls that prohibit or severely restrict locations where new potable wells can be installed, there is low potential for use as a source of drinking water because of these institutional controls.

- **Proximity to saltwater and actual TDS values:** Although a large portion of the A-aquifer at Parcel D meets the federal TDS criterion (10,000 mg/L) to be considered as a potential source of drinking water, the actual TDS values are still high. Additionally, much of Parcel D is near the Bay, which contains saltwater or brackish water. Together, these two site-specific factors suggest that TDS values will increase as a result of saltwater intrusion if significant quantities of water are withdrawn from the A-aquifer at Parcel D. They further suggest that this aquifer will ultimately not be suitable for use as a source of drinking water. Based on these site-specific factors, the A-aquifer at Parcel D is considered to have low potential for use as a source of drinking water.

- **Historical and Current Groundwater Use:** A-aquifer groundwater at HPS has never been and is not currently used as a drinking water source (PRC, LFR, and U&A 1996). San Francisco currently obtains its municipal water supply from the Hetch Hetchy watershed in the Sierra Nevada and plans to continue using the Hetch Hetchy watershed as a drinking water source in the reasonably foreseeable future (Tetra Tech 1999). Based on historical and current use, A-aquifer groundwater at HPS has low potential to be used as a future drinking water source.

- **Cost of Cleanup to Federal Drinking Water Standards**: Antimony, arsenic, chromium, magnesium, nickel, thallium, zinc, and other metals are components of the Franciscan Formation bedrock and bedrock-derived fill that underlies HPS. The A-aquifer contains fill material derived from the Franciscan Formation. During the RI, Hunters Point groundwater ambient levels (HGAL) were estimated for naturally occurring metals (PRC, LFR and U&A, 1996). The HGALs for antimony, arsenic and thallium exceed their respective maximum contaminant levels (MCL), even though these MCLs are federal drinking water standards. While the Navy has not calculated the cost to reduce concentrations of these naturally occurring metals to below MCLs in groundwater, the cost would likely be prohibitive, and it may be technically impracticable to do so. Based upon this site-specific factor, there is low potential for the A-aquifer groundwater at HPS to be used as a drinking water source.

As shown on Figures 2-7 and 2-12, the B-aquifer is present in only a few small, laterally discontinuous areas at Parcel D. The largest area of the B-aquifer at Parcel D is near the center of Parcel D and is interpreted to be 20 feet thick, 1,500 feet wide, and 1,000 feet long. TDS concentrations in groundwater samples collected in this area of the B-aquifer were generally below state and federal TDS criteria. Figure 2-12 presents the maximum TDS values detected in the B-aquifer monitoring wells. Based on the TDS data alone, the B-aquifer at Parcel D would be considered suitable as a potential source of drinking water. The evaluation of other site-specific factors in this area indicated that the B-aquifer has low potential for use as a source of drinking water. These other site-specific factors include (1) the limited volume and storage capacity of the confined B-aquifer, (2) the existence of institutional controls that prohibit installing water supply wells within City and County of San Francisco limits and locating wells within 50 feet of a sanitary sewer or storm drain (see Figure 2-12), and (3) the current and historical uses of the B-aquifer (which has never been used for water supply at HPS). Therefore, the B-aquifer is considered to have a low potential for use as a source of drinking water. However, because of agreements made with the BCT on the HHRA, the groundwater ingestion pathway is included in the risk assessment for the B-aquifer. This assumption provides an additional layer of conservatism for the protection of human health at HPS.

2.3 PARCEL D INVESTIGATION HISTORY

Parcel D has been investigated following the CERCLA process. Parcel D underwent a sequence of initial investigations from 1988 to 1996. Investigations began with a preliminary assessment, which involved record searches, interviews, and limited field investigations. Sites that required further investigation were considered during the site inspection phase, which involved collection and evaluation of additional field data. Finally, sites that required even further investigation were considered during the RI phase. The RI was followed by a FS, proposed plan, ROD, risk management review (RMR), and revised FS. The following subsections summarize the significant aspects of the RI, FS, proposed plan, ROD, RMR, and revised FS.

Table 2-4 briefly describes each IR site at Parcel D and summarizes past cleanup actions and recommendations presented in past reports for Parcel D. Detailed descriptions and findings can be found in the original documents. In the various investigations and reports, areas requiring remediation were given unique alpha-numeric identifiers. Large areas were called remediation areas and their identifiers started with "RA." Small areas were called "*de minimis*" areas and their identifiers started with "DM." In order to present information consistent with previous reports, Table 2-4 includes these alpha-numeric identifiers.

2.3.1 Remedial Investigation

A draft final Parcel D RI was completed on October 25, 1996, and addressed the original 27 IR sites in Parcel D (PRC, LFR, and U&A 1996). The RI became final on January 31, 1997, following submission of responses to agencies' comments on the draft final version (Tetra Tech 1997b). The two most significant aspects of the RI report are (1) the site characterization of contaminants and (2) the HHRA. No ecological risk assessment was conducted because there is no ecological habitat of concern at Parcel D because most of the parcel is an industrial setting covered by buildings or pavement.

The HPS IR sites were characterized using biased sampling in areas where chemicals were known to have been used, stains were observed, or the potential for spills existed. These IR sites were delineated as buildings or areas that had been used for various industrial processes. The site chemical characterization presented in the RI compared chemical compounds in the soil and groundwater with a variety of regulatory screening criteria concentrations. Those chemicals that exceeded screening criteria were posted on a series of IR site maps. The maps illustrated the location of chemicals with respect to potential sources, and recognizable spatial patterns. The RI documented the site characterization activities.

The HHRA conducted for Parcel D during the RI was similar to that conducted in the other parcels at HPS and was designed by the HPS BCT. All of the parcels were evaluated for three human health risk scenarios: (1) the current land use, which was industrial; (2) a future industrial land use; and (3) a future residential land use. The question of the appropriate exposure area for a site industrial worker or resident was discussed by the BCT prior to completing the HHRA, and the BCT decided to use a grid system for conducting the parcel-wide risk assessment. The final grid size agreed to by the BCT was 0.5 acre for an industrial scenario. In addition, it was assumed that construction and maintenance activities could bring soil from a depth of 10 feet to the surface and, therefore, contamination from 0 to 10 feet below ground surface (bgs) should be considered in the HHRA. As a result, the human health risk was calculated for all of the samples between 0 and 10 feet bgs within the 0.5-acre grid cell, and the total cumulative risk for that cell was reported in the HHRA.

No risk management evaluations were included as part of the RI. Instead, the BCT decided that all of the 27 IR sites described in the RI would be assessed during the FS evaluation since all 27 IR sites contained exposure areas (HHRA grid cells) that exceeded at least one of the screening criteria; that is, an excess lifetime cancer risk (ELCR) greater than 10^{-6} for a future industrial worker or resident, a segregated HI greater than 1, or lead concentrations exceeding 1,000 milligrams per kilogram (mg/kg).

2.3.2 Feasibility Study

The draft final Parcel D FS was submitted on January 24, 1997 (Tetra Tech 1997a), and became final on August 29, 1997, following an extended period of written comments and responses (Tetra Tech 1997d). The FS used the results and analyses in the RI report to identify, screen, and evaluate remedial alternatives for Parcel D and to define areas for proposed remedial action. Three different cleanup scenarios and associated cleanup goals were considered in the FS. Scenario 1 consisted of cleanup to the industrial land use scenario with a 10^{-5} ELCR; Scenario 2 consisted of cleanup to the industrial land use scenario with a 10^{-6} ELCR; and Scenario 3 consisted of cleanup to the residential land use scenario with a 10^{-6} ELCR. For each of these scenarios, the costs of cleanup and the areas that exceeded the cleanup goals were defined for each of the remedial alternatives proposed. Each scenario also considered cleanup of soils representing an HI greater than 1 and lead concentrations greater than 1,000 mg/kg.

The FS used the RI data to delineate those areas that exceeded the different cleanup goals for each reuse scenario and cleanup level. The HHRA results were used to identify chemicals that were risk drivers, and the RI characterization data were used to define the extent of the cleanup areas. The lateral extent of the soil cleanup areas in each IR site was determined by either (1) defining the interpreted lateral extent of chemicals considered risk drivers for the area, or (2) assuming an 8-foot-wide by 8-feet-long area for locations having a single boring with chemicals exceeding risk-based concentrations (RBC). The 8-foot by 8-foot area was proposed based on the assumed smallest possible sized excavation that would not requiring sidewall shoring. The vertical extent of each area was determined to be 2 feet below the deepest sampling location that contained a chemical exceeding the screening criteria, the depth to the shallowest water table, or 10 feet bgs, whichever was shallowest. The industrial land use scenario and cleanup goals resulted in 20 IR sites containing soil cleanup areas, while the residential scenario and cleanup goals resulted in 23 IR sites containing soil cleanup areas. No risk management evaluations were conducted as part of the FS, and all soil cleanup areas that exceeded at least one of the various cleanup criteria under each reuse scenario were identified in the final FS.

2.3.3 Proposed Plan and Record of Decision

The proposed plan for Parcel D was published on May 11, 1997 (Tetra Tech 1997c), and a public meeting was held on May 21, 1997. The Navy's preferred remedy was to excavate the contaminated soils, dispose of the soils off site, and backfill with clean soil. The cleanup goal chosen corresponded to a cumulative 10^{-5} ELCR and an HI of 1 based on an industrial reuse scenario and lead concentrations in soil of 1,000 mg/kg. One of the 20 IR sites was not included in the proposed plan because the parcel boundary was changed so that IR-36 was excluded from Parcel D and included in Parcel E. As a result, the proposed plan included 19 IR sites for soil remediation.

The comments received during the public comment period did not change the proposed remedy or the areas proposed for remedial action. The comments did raise the issue of the recommended 10^{-5} ELCR cleanup goal, with a cleanup goal of 10^{-6} ELCR being preferred by some responders. The Navy determined that the original recommended cleanup goal of 10^{-5} ELCR was the most appropriate approach, and it was included in the ROD.

The draft Parcel D ROD was submitted to the regulatory agencies on November 3, 1997 (Tetra Tech 1997e). As presented in the draft ROD, the selected remedy was excavation and off-site disposal of soils based on the cleanup goals described in the proposed plan. Subsequent to the submittal of the draft ROD, the costs and environmental improvements associated with the selected soil remedy for Parcel D were reviewed by the Navy. Navy concerns regarding the level of risk reduction, cost effectiveness of the cleanup approach, and discussions with other members of the BCT resulted in the RMR.

2.3.4 Risk Management Review Process

The RMR process was developed and conducted during a series of meetings held by the Navy and the regulatory agencies from January through April 1999. The process employed various criteria and decision rules to reevaluate whether remedial actions were required at 19 of the 27 IR sites in Parcel D that were originally determined to require remedial actions for soil. The primary decision questions were:

- Is the site adequately characterized?
- Has a change in regulatory screening criteria eliminated risk drivers at the site?
- Are risk drivers associated with ambient conditions in fill or asphalt surface cover?
- Have removal actions or other actions reduced risk to an acceptable level?
- Are there other mitigating factors that reduce risk to an acceptable level?

The RMR consisted of a comprehensive evaluation of each IR site. The data for the entire site, including the nature and extent of soil contamination and specific chemicals driving the risk to human health were reviewed and evaluated during the 10 RMR meetings. All soil contamination identified between 0 and 10 feet bgs was considered in the RMR process. During the review, the nature and extent of soil contamination was re-evaluated, including assessment of the major risk "drivers" defined as the chemicals that contribute over 90 percent of the total risk, and mitigating factors associated with the type and location of chemicals detected in soil samples. The adequacy of the site characterization was considered a significant evaluation factor by the risk management review team and was one of the first aspects reviewed. The reasonably anticipated future use of the Parcel D sites, as specified in the July 1997 Redevelopment Plan, was also considered during the RMR process (San Francisco Redevelopment Agency 1997).

Regulatory screening criteria had changed since the HHRA was conducted for the RI. During the RMR process, the 1998 EPA preliminary remediation goals (PRG) were used to evaluate site risks. The 1998 PRGs differed from the 1995 PRGs used in the RI. The 1998 PRGs incorporated revised input parameters. Since 1995, EPA had developed new guidance for risk assessment input parameters for several classes of chemicals, which was used during the RMR process. The revised 1998 EPA guidance included (1) recommending evaluating beryllium only under the inhalation route for cancer effects and eliminating the oral slope factor; (2) updated oral and inhalation slope factors for the polychlorinated biphenyls (PCB) Aroclor-1254 and Aroclor-1260; (3) new reference doses for approximately 20 noncancer chemicals; (4) updated soil-to-skin adherence assumptions for adult and child receptors; and (5) updated skin surface area values for adult and child receptors (EPA 1998d).

During the Parcel D RMR process, the significance of arsenic detections was balanced according to several factors: (1) the 1998 residential Region 9 PRG, which was 0.38 part per million (ppm) for a 1 in a million excess cancer risk and 21 ppm for noncancer endpoints, and (2) the HPAL for arsenic at 11 ppm, which is the 95th percentile of the unimpacted soil concentrations detected at HPS. The BCT agreed to use "twice the HPAL" or 22 ppm as the site-specific arsenic goal, which is consistent with EPA's general goal to manage risks to within the risk range (1×10^{-4} to 1×10^{-6}) and below an HI of 1. However, spatial distributions, both vertically and horizontally, operational histories of the site, sampling density, soil horizons, volume of soil impacted, and concentrations were also considered to evaluate the need for CERCLA response action. It should be noted that the 1999 industrial PRG for arsenic's noncancer endpoints was 22 ppm.

The Navy agreed that EPA's guidance for remedial actions at Superfund sites with PCB contamination was appropriate guidance to be considered for the RMR process (EPA 1990b). This guidance states that action levels in the range of 10 to 25 mg/kg should be established for PCB cleanups in soil at industrial sites, with a limit of 1 mg/kg for residential use. After considering site-specific conditions at HPS that may affect exposure, the Navy selected the conservative end of the industrial range provided in the EPA guidance (EPA 1990b). Therefore, under the RMR process, a total PCB action level of 10 mg/kg was considered by the Navy as protective of human health and the environment for industrial reuse areas, such as Parcel D. As noted in the EPA guidance, a PCB concentration of 10 mg/kg equates to an estimated ELCR of 1×10^{-5}, under an industrial reuse scenario. Although the Navy and EPA agreed it was appropriate to consider this guidance during the Parcel D RMR process, DTSC disagreed with this approach and preferred to use the 1998 industrial PRG of 1.3 mg/kg, which equates to an ELCR of 1×10^{-6}.

At the conclusion of the RMR process, the review team confirmed or eliminated sites from proposed remedial action based on current risk. After completion of the review, all sites fell into one of the following three categories: (1) sites that the team agreed no response action was required, (2) sites that the team agreed response action was required, and (3) sites that the team did not yet agree on the course of action. The results of the RMR process are documented in the draft final Parcel D RMR process report (Tetra Tech 2000a). Table 2-4 briefly summarizes the Navy's RMR recommendations and Appendix J, Attachment J-2, includes additional RMR summary tables from the Parcel D RMR process report.

The Navy conducted a TCRA for soil sites based on the results of the RMR process, which are later described in Section 2.4 of this report. The TCRA cleanup goals are listed in the "Final Sampling and Analysis Plan Parcel D Soil Site Delineation" (Tetra Tech 2000b).

2.3.5 Draft Revised Feasibility Study

The Navy submitted the draft Parcel D revised FS report on March 8, 2002. The revised FS combined existing RI data with new data collected after completion of the RI. The data were summarized and evaluated in the revised FS report to refine the site conceptual model, further define the nature and extent of contamination, assess potential risks based on existing site conditions, and develop and evaluate revised alternatives. The data evaluation included (1) a comparison of new and existing data to updated screening criteria, (2) a revised evaluation of groundwater beneficial uses and exposure pathways, and (3) a revised assessment of potential risk posed through exposure to soil and groundwater at Parcel D. Following data evaluation, RAOs were developed. These RAOs were stated in terms of a risk range rather than specific concentrations for contaminants. These RAOs were determined to be insufficient to support the conveyance agreement subsequently signed with the City and County of San Francisco (Navy and San Francisco Redevelopment Agency 2004). Remedial alternatives developed in the draft Parcel D revised FS report included no action and institutional controls.

2.4 PARCEL D REMOVAL AND CLEANUP ACTIONS

This section discusses removal and cleanup actions that were conducted at Parcel D. Completed actions include the facility-wide underground storage tank (UST) and aboveground storage tank (AST) removal actions, the sandblast grit removal action, the Pickling and Plate Yard (IR-09) removal action, the exploratory excavation (EE) removal action, the storm drain sediment removal action, the non-VOC soil TCRA, the soil stockpile removal action, the radiation TCRA, and the waste consolidation cleanup action. Further action may be conducted under the facility-wide radiation TCRA. No additional removal actions are planned for Parcel D. Each removal and cleanup action is discussed below.

2.4.1 Polychlorinated Biphenyl Transformer Removal

In 1988, 199 transformers located throughout HPS were removed from their original locations by American Environmental Management Corporation and the Navy's Public Works Department (Harding Lawson Associates 1990).

After the transformer cleanup action, YEI Engineers, Inc. conducted an investigation of transformer locations at HPS in 1988. During this investigation, all known oil-containing electrical equipment were inspected, inventoried, and sampled (YEI Engineers, Inc. 1988). In 1994, a basewide site inspection of the former transformer locations was conducted (Harding Lawson Associates 1994). Also in 1994, the transformer sites were designated as IR-51 in compliance with the basewide IR Program.

2.4.2 Parcel D Underground and Aboveground Storage Tank Removal Actions

The Navy removed or closed in place 10 USTs at Parcel D during the Phase I UST removal program in 1991 and the Phase II removal program in 1993. Of these 10 USTs, 9 were removed and 1 was closed in place. The Parcel D USTs ranged in size from 30 to 7,000 gallons, and contained gasoline, diesel, waste oil, hydraulic fluids solvents, or fuel oils. The location, capacity, contents, and status of each UST and AST at Parcel D are summarized in Appendix G of the draft final Parcel D RI report (PRC, LFR, and U&A 1996). Figure 2-13 shows the UST sites at Parcel D.

2.4.3 Parcel D Sandblast Grit Cleanup Action

Sandblast operations were conducted at numerous locations at HPS, including Parcel D. These operations generated sandblast grit that may have contained paint chips, heavy metals, and oil. Between 1991 and 1995, 4,665 tons of sandblast grit was collected and consolidated in Parcel E. Subsequently, about 245 tons of sandblast grit was collected from eight small piles around HPS. Approximately 90 tons of sandblast grit was removed from IR-44 in Parcel D and recycled (Battelle 1996). The grit was sent to an asphalt plant, where it was reused in the manufacture of asphalt. This cleanup action was completed in 1995 (Battelle 1996).

2.4.4 Pickling and Plate Yard Removal Action at IR-09

Between 1947 and 1973, the Navy used the Pickling and Plate Yard at IR-09 for industrial metal finishing and painting (PRC, LFR, and U&A 1996). Steel plates were dipped in acid baths, dried on concrete drying racks, and painted with a corrosion-resistant zinc chromate-based paint. Residual hazardous liquid and sludge remained in the dip sumps, and residual paint covered several steel and concrete structures.

The removal action at the Pickling and Plate Yard began in November 1994 and was completed in March 1996. The purpose of the removal action was to remove and dispose of hazardous materials and structures affected by hazardous surface residues at the site. The following structures were located at the Pickling and Plate Yard: three partially below-ground steel pickling sumps lined with acid-resistant brick and housed in an open concrete containment vault; concrete plate drying racks; concrete plate storage racks; three empty acid storage tanks; two buildings; and a large overhead crane system (PRC, LFR, and U&A 1996). Activities completed during the removal action included (1) removing and disposing of the pickling sumps, including the brick lining; (2) securing the containment vault; (3) removing and disposing of zinc chromate residue; and (4) demolishing and disposing of various structures, including three acid storage ASTs, and the plate storage and drying racks. Approximately 200,000 pounds of hazardous waste liquids; 1,500 cubic yards of hazardous waste solids; 100,000 pounds of nonhazardous liquids; and 350,000 pounds of scrap metal were disposed of during this removal action. After the structures had been removed, surface soil samples were collected for analysis of chromium VI. The samples were analyzed using a field test kit. Several samples showed elevated results.

2.4.5 Parcel D Exploratory Excavation Removal Action

EEs were conducted to remove hazardous substances in soil at sites determined to pose a threat to human health and the environment, as documented in the EE action memorandum (Navy 1996). Five EE sites (EE-12 and EE-14 through EE-17) were located in Parcel D (see Figure 2-13). Removal actions at these EE sites are summarized below and shown on Figure 2-13.

- **EE-12**: Soil containing metals, PCBs, polynuclear aromatic hydrocarbons (PAH), and petroleum hydrocarbons was excavated from a 34-by-25-by-28-foot triangular area to an average depth of 10 feet bgs. Approximately 130 cubic yards of soil was excavated. EE-12 is located in IR-33 North.

- **EE-14:** Soil containing metals, PCBs, and petroleum hydrocarbons was excavated from a 13-by-26-foot area to an average depth of 3 feet bgs. Approximately 37 cubic yards of soil was excavated. EE-14 is located in IR-37.

- **EE-15 and EE-16:** EE-15 and EE-16 are adjacent sites and were excavated as one area. Soil containing metals and petroleum hydrocarbons was excavated to a depth of 2 feet bgs from an irregularly shaped area measuring approximately 900 square feet. Approximately 70 cubic yards of soil was excavated. EE-15 and EE-16 are located in IR-53.

- **EE-17**: Soil containing metals and petroleum hydrocarbons was excavated to a depth of 7 feet bgs from an irregularly shaped area measuring approximately 420 square feet. Approximately 110 cubic yards of soil was excavated. EE-17 is located in IR-70.

Excavated soil was disposed of at an off-site landfill. At each EE site, confirmation samples were collected and analyzed to ensure that the removal action criteria were met. Subsequently, the excavations were backfilled and the sites were regraded. The field activities for the EE removal action began in mid-1996 and were completed in February 1997. All field activities conducted and analytical data collected during the EE removal action are documented in the completion report (International Technology Corporation [IT Corp.] 1998).

2.4.6 HPS Storm Drain Sediment Removal Action

Sediment was removed from the storm drain system to lessen potential transport of contaminated sediments through the system to the Bay. Site inspection results indicated that (1) storm drain sediments in Parcels B, C, D, and E contained hazardous substances at concentrations that may have posed a risk to the environment and (2) storm drain integrity is poor in several locations (PRC, LFR, and U&A 1996). The removal action involved removal of sediments and debris from the storm drain lines, catch basins, and manholes; pre- and post-cleaning video inspections of the pipelines; and water jetting of the pipelines, catch basins, and manholes. Sediments generated during the removal action were dewatered, sampled, and analyzed for appropriate disposal. Over 1,200 tons of sediment was removed from the storm drain system including Parcel D. The removal action began in October 1996 and was completed in early 1997 (IT Corp. 1997).

2.4.7 Parcel D Time-Critical Removal Action for Non-Volatile Organic Compounds in Soil

In 2001, the Navy conducted a TCRA to remove hazardous substances in soil at sites determined to pose a threat to human health under the proposed future reuse scenario (residential for IR-37 and industrial for all other Parcel D sites). Soil at Parcel D did not contain VOCs; as a result, the TCRA addressed only non-VOC compounds. TCRA sites were identified during the RMR process and were further characterized during field investigations prior to the TCRA. TCRA sites were identified at IR-08, IR-09, IR-37, IR-53, IR-55, and IR-65. Removal actions conducted at these sites are summarized below.

- **IR-08**: Approximately 13 cubic yards of soil containing PCBs was excavated from RA-4. The cleanup goal for PCBs was 1 mg/kg.

- **IR-09**: Soil in DMs 6864, 6965, 6967, and 7167 was further characterized for chromium VI. This investigation provided additional characterization of soil after the Pickling and Plate Yard removal action. Concentrations of chromium VI in these areas were less than the TCRA cleanup goal of 10 mg/kg in this area

- **IR-37:** Approximately 25 cubic yards of soil containing PCBs was excavated from RA 37-1; the cleanup goal for PCBs was 1 mg/kg. Approximately 44 cubic yards of soil containing antimony was excavated from RA 37-2. The cleanup goal for antimony was 19 mg/kg in this area.

- **IR-53:** Approximately 6 cubic yards of soil containing PAHs was excavated from DM 11260. The cleanup goal for benzo(a)pyrene was 0.33 mg/kg.

- **IR-55:** Approximately 7 cubic yards of soil containing lead was excavated from DM 10676. The cleanup goal for arsenic was 11 mg/kg throughout Parcel D.

- **IR-65:** Approximately 12 cubic yards of soil containing arsenic was excavated from DM 8866. The cleanup goal for arsenic was 11 mg/kg.

Excavated soil was disposed of at an off-site landfill. At each site, confirmation samples were collected and analyzed to ensure that the TCRA cleanup goals were met. Subsequently, the excavations were backfilled and the sites were regraded.

Steam and fuel lines were also addressed during the TCRA. The steam lines were constructed in the 1950s and operated until 1984. The steam pipes are covered in asbestos pipe lagging insulation in most areas. The Navy leased portions of HPS to Triple A from 1976 to 1986; it was alleged that Triple A used sections of the abandoned steam lines to transfer waste oil. Steam lines that were saturated with oil were removed under the TCRA. Most steam lines on Parcel D were left in place after the asbestos abatement. Areas where the asbestos was damaged were inspected for liquids, oily waste, or staining. Steam lines were pressure tested with compressed air when wipe samples exceeded project requirements or when visible waste oil was in the pipe. Samples of liquids or wipe samples from the inside of the pipe were collected. Asbestos was not removed on pipes that remained in place. The inside surface of the pipes were cleaned out with a vacuum truck followed by pressure washing where residual fluids remained. In addition, soil samples were collected where releases were suspected. In a few instances, soil sample results exceeded the TCRA goals, resulting in further excavation until bottom samples met the goals of the TCRA (Tetra Tech 2001b). In addition, a 150-foot segment of fuel line was removed from Parcel D during the TCRA. Waste materials were disposed of in appropriate off-site permitted facilities. All field activities conducted and analytical data collected during the TCRA are documented in the closeout report (Tetra Tech 2001b).

2.4.8 Parcel D Radiological Time-Critical Removal Action

A radiological TCRA is ongoing at several locations at Parcel D. These actions are discussed in the historical radiological assessment of HPS, completed in August 2004 (RASO 2004). The radiological TCRA began at Building 364 and the surrounding area in February 2001 to remove contamination from the former site of a cesium-137 spill. Soil and a waste tank pit were removed. Further investigation, remediation, and surveying were conducted in 2002 (RASO 2004).

The historical radiological assessment identified the following Parcel D sites as radiologically impacted: Building 274, Building 313 site, Building 313A site, Building 317 site, Building 322 site, Building 351, Building 351A, Building 364, Building 365, Building 366, Building 383 Area, Building 408, Building 411, the former NRDL site on Mahan Street, the Gun Mole Pier, Building 813, and Building 819 (RASO 2004). The historical radiological assessment summarizes the assessments, investigations, and surveys completed and the recommendations for the impacted sites at Parcel D (RASO 2004). Recommended actions are ongoing under the facility-wide radiological TCRA. The action memorandum for the facility-wide TCRA specifies that radiological contamination will be addressed by removal and off-site disposal (Navy 2001). Documentation of completed activities is under preparation.

2.4.9 Parcel D Soil Stockpile Removal Action

In July and August 2003, the Navy inventoried all the stockpiles at HPS and identified 37 piles located within the current Parcel D boundary (Tetra Tech and ITSI 2005). Two other stockpiles (SPD37 and SPD41) were formerly located within Parcel D but are now located within the boundary of Parcel E, based on the 2005 revised boundary between the two parcels. Each stockpile was surveyed to document the location, estimate the volume, and establish photo documentation of each pile. Each stockpile was also assigned a unique identification number. All 37 stockpiles located at Parcel D are shown on Figure 2-14.

In February 2004, nine stockpiles were removed from Parcel D (SPD23 through SPD31) as part of a TCRA. All of the stockpiles consisted primarily of soil, except for the three stockpiles in or near IR-17 (SPD28, SPD29, and SPD30), which consisted mostly of asphalt. Soil samples were collected from the stockpiles to characterize the material for appropriate off-site disposal, and confirmation samples were collected from beneath the stockpiles that were located on native soil to assess if the removal action was complete (Tetra Tech and ITSI 2005). Table 2-5 lists the 28 Parcel D stockpiles for future removal, and Figure 2-14 shows the location of these piles. Based on the 2003 investigation, these stockpiles contain approximately 560 cubic yards of material for disposal, including an estimated 540 cubic yards of soil and 20 cubic yards of asphalt and other material.

As part of the same TCRA used for the soil stockpile removal, the Navy also excavated a buried fuel line site that was given the unique identifier DM BK32. This DM area designation was not part of the RMR process, and this DM designation does not appear as part of the IR evaluation in Table 2-4. The removal at DM BK32 consisted of clearing the surface area, excavating soils, surveying the excavation area, collecting confirmation samples, disposing of excavated soil off site, and backfilling the excavation (Tetra Tech and ITSI 2005).

An additional area (DM 9363) was proposed in the TCRA for removal. This site is located inside Building 306 in IR-35. The building formerly housed a transformer that leaked PCBs and containers that reportedly contained PCBs. However, the evidence was only visual (staining in the underlying concrete and gravel). Since no removal was undertaken at the site, an additional investigation of this area is recommended.

2.4.10 Parcel D Waste Consolidation Cleanup Action

The purpose of the waste consolidation cleanup action was to identify and address potential environmental issues associated with the industrial use of buildings in Parcel D that could impact the planned transfer of the property to the City and County of San Francisco of San Francisco. From April to July 2002, surveys were conducted in and around 69 buildings in Parcel D to identify industrial process equipment, materials, structures, and other miscellaneous items that could pose a health risk and to locate and identify Resource Conservation and Recovery Act (RCRA), non-RCRA, or universal wastes. From May 2002 to April 2003, samples were collected and analyzed from various industrial process equipment and waste consolidation items to identify those requiring action (decontamination, labeling, or removal) to support the Parcel D property transfer. From April 2002 to June 2003, decontamination and waste consolidation and disposal activities were conducted. Decontamination and waste consolidation and disposal activities are summarized below.

- Encapsulating or removing asbestos-containing material
- Removing and disposing of structural materials, paint booths, and numerous abandoned waste items
- Removing and disposing of hoods, vents, and ducts associated with industrial processes
- Removing or disabling existing aboveground storage tanks
- Cleaning industrial process-related sumps, vaults, trenches, and equipment foundations

At the conclusion of the decontamination and waste consolidation activities, unoccupied buildings in Parcel D were secured to limit unauthorized access and to aid in maintaining the buildings in a condition suitable for transfer (Foster Wheeler Environmental Corporation 2003).

2.4.11 Total Petroleum Hydrocarbon-Contaminated Soil Excavation

In 2004, one location, CAA-4, at Parcel D was excavated to remove TPH-contaminated soil (see Figure 2-13). The removal was conducted under the HPS TPH Corrective Action Program, which addresses areas of TPH contamination. The goal of the excavation activities was to remove soil that contained TPH at concentrations exceeding the cleanup level of 3,500 mg/kg. The excavation footprint was delineated based on a screening evaluation of existing analytical data. After excavation, confirmation samples were collected and analyzed for TPH and TPH-related chemicals of concern (TPA-CKY 2005).

2.4.12 Storm Drain and Sanitary Sewer Removal Action

In 2007, the Navy began investigating the storm drains and sanitary sewer lines for potential radiological contamination. These lines will be removed and disposed of because the investigation requires removing these utilities to begin the radiological testing. This action is currently ongoing under the "Revised Basewide Storm Drain and Sanitary Sewer Removal Action Work Plan" and is expected to be completed in 2008 (Tetra Tech EC 2007).

2.5 EXTENT OF CONTAMINATED SOIL AND GROUNDWATER

This section presents an overview of the current extent of contamination present in Parcel D soil and groundwater based on data collected through June 2004. The COCs identified based on the results of the HHRA and environmental evaluation summarized in Section 3.0 were used to focus the discussion of soil and groundwater contamination presented in this section. In accordance with the HHRA in Section 3.0 and Appendix B, COCs are those analytes that drive risk in ECLR risk greater than 1×10^{-6} or an HI greater than 1. In addition, COCs in groundwater were identified that present a potential threat to the Bay based on the evaluation of groundwater data as compared to surface water screening criteria (see Section 3.2). These COCs are also the focus of this FS report and will require remedial action by the Navy.

The nature and extent of contaminants in soil and groundwater at Parcel D were presented in greater detail in the previous RI and FS reports (PRC, LFR, and U&A 1996; PRC and LFR 1997). The nature of contaminants at Parcel D can mostly be attributed to industrial activities by the Navy or other tenants, except for several metals found at ambient concentrations.

The Navy maintains a comprehensive database of analytical results reported at HPS for both soil and groundwater. Because this section is meant to provide an overview of the extent of contaminants that pose the greatest risk at Parcel D, sample-specific data are not presented in the figures and tables of this section. Sample-specific information is presented in Appendix A. Appendix A includes figures showing sampling locations with sample identification labels and tables of sample analysis data for both Parcel D soil and groundwater. For soil sample data, soil sampling locations that were removed as part of an interim action have been excluded from these tables. Confirmation sample data collected during these removal actions are included in the data set. The groundwater sample data tables include all available analytical data through June 2004.

The Appendix A data tables are provided electronically on compact disk due to the large volume of information.

Section 2.5.1 describes the extent of the soil COCs at Parcel D. Figure 2-15 presents all soil sampling locations within Parcel D and indicates those locations that have been removed. Figure 2-15 is presented at a scale that shows the density of soil sampling across Parcel D, but does not allow for the inclusion of sample identification labels. Figures showing the sampling locations with their identification labels are included in Appendix A as referenced on Figure 2-15. Section 2.5.2 describes the extent of the selected groundwater COCs at Parcel D. Figure 2-16 presents the groundwater sampling locations in Parcel D.

2.5.1 Parcel D Soil Characterization

The following sections briefly discuss the analytical groups for which soil was analyzed: metals, VOCs, semivolatile organic compounds (SVOC), pesticides and PCBs, and cyanide. For each analytical group, data summary tables list various statistics, including percent detected, average concentration, and the standard deviation. The percent detected shows the frequency at which the analyte is detected. Standard deviation is a statistic that shows the variability of the data; a large standard deviation indicates that the data values differ greatly from the mean, and a small standard deviation indicates that they do not vary greatly from the mean.

Figures 2-17 through 2-28 present soil characterization results for each of the soil COCs. These figures show all sampling locations where the COC was analyzed and each location is symbol-coded as nondetect, detected below the comparison criteria, or detected above the comparison criteria. The comparison criteria for metals (except chromium VI) are the HPALs. HPALs are statistically calculated values representing ambient concentrations in soil for each metal (PRC 1995). In the case of chromium and nickel, the HPAL is a site-specific concentration based on a regression analysis using data for magnesium or cobalt. Samples were analyzed for magnesium, cobalt, or both where nickel or chromium was a COPC to obtain data for the regression analysis used to calculate the site-specific HPAL. An HPAL has not been derived for chromium VI and is simply compared with the laboratory's reporting limit. The comparison criterion for PAHs is the laboratory reporting limit of 0.33 mg/kg in soil. The laboratory reporting limit is the lowest practical concentration at which the laboratory can accurately detect the analytes. When concentrations are found above the laboratory reporting limit, but less than EPA's method detection limit, the data are qualified and flagged as an estimated value, but reported as a positive detection. In this FS report, all valid qualified data above the laboratory reporting limit and all valid data reported above the method detection limit are considered detected concentrations. These qualified detections are shown in the summary statistical tables presented in this section.

2.5.1.1 Characterization of Metals in Soil

Soil samples were collected and analyzed for 25 individual metals at Parcel D. Table 2-6 presents the statistical information for each of these metals for soil samples collected from 10 feet bgs or less, which represents near-surface soil conditions; Table 2-7 presents the statistical information for each of these metals for soil samples collected at depths greater than

10 feet bgs, which represent subsurface soil conditions. Tables 2-6 and 2-7 also provide a comparison of metal concentrations with their HPAL.

The Navy has evaluated potential sources of metals at Parcel D to assess where Navy activities may have contributed to metals concentrations in soil. For example, lead may be associated with industrial activities or paint. Section 3.0 and Appendix B present the risk associated with all metals based on the samples where the soils remain in place.

In addition to the industrial sources identified, the presence of metals across Parcel D is likely related to the fill and naturally occurring bedrock material. A group of metals related to the bedrock fill quarried to build HPS in the 1940s consistently exceeded risk-based criteria across Parcel D. These metals occur in the local HPS bedrock and were distributed throughout all parcels as HPS was built. The resulting distribution of ubiquitous metals concentrations in soil is nearly random in areas where fill is present. In this report, the term "ubiquitous" refers to metals that are naturally occurring or are in the same concentration ranges as naturally occurring metals in the source material (including material from the same geologic formations in the San Francisco area) that was used for filling at HPS. The Navy acknowledges that industrial sources of metals exist at HPS and that there is a potential that some metals in soil may be due to industrial sources and not from a naturally occurring source. The Navy has worked to remove contaminants from industrial sources during the removal actions taken to date, including exploratory excavations and time-critical removal actions. The Navy acknowledges that the DTSC does not agree with the Navy's position that ubiquitous metals are naturally occurring. Remedial alternatives developed in this FS address these concentrations of metals, regardless of their source."

The metals analysis data for all soil samples collected from near-surface depths are used in the revised HHRA presented in Section 3.0. The results of the HHRA identified three metals COCs that are the principal risk drivers for this analyte group: arsenic, lead, and manganese. In addition, chromium VI is considered a potential COC in soil because it is a possible source for the chromium VI plume present in the A-aquifer (see Section 2.5.2). As a result, these four metals are discussed below.

Arsenic

Arsenic is a naturally occurring semi-metal associated with bedrock of the Hunters Point Shear Zone. Figures 2-17 and 2-18 show analytical results for arsenic in soil samples collected at Parcel D from the near-surface and from the subsurface, respectively. Both of these figures show a widespread, ubiquitous distribution of arsenic detections. Less than 5 percent of detected arsenic concentrations exceeded the HPAL. The detections of arsenic concentrations greater than the HPAL are shown as red sampling locations on these figures, and indicate distributions throughout Parcel D, with no unique area or distinctive pattern that would indicate a release of arsenic. Review of the data shows that most of the detected concentrations above the HPAL of 11.1 mg/kg are within 30 percent of the HPAL. The highest detection, at boring IR65B004, was 47 mg/kg. Based on the results of the HHRA, remedial action is planned to address arsenic in soil above remediation goals.

Chromium VI

Chromium VI is considered to be an anthropogenic metal released during shipyard operations. Although chromium VI was not identified as a COC in soil based on the HHRA (see Section 3.0), characterization of chromium VI in soil at Parcel D is important because it is a potential source of groundwater contamination from activities at HPS. Figures 2-19 and 2-20 show analytical results for chromium VI in soil samples at Parcel D collected from the near-surface and from the subsurface, respectively. The statistics for chromium VI for the near-surface and subsurface soil intervals are reported in Tables 2-6 and 2-7. Both Figures 2-19 and 2-20 show the distribution of the detected results; the frequency of detections was less than 20 percent for both depth intervals. These figures show three areas where chromium VI primarily occurs in soils, near IR-09, IR-35, and IR-37. Comparing the analysis data for samples from the two depth intervals shows a higher frequency of detection and higher maximum detected concentration for the samples collected from the subsurface (greater than 10 feet bgs), compared to the samples collected from the near (0 to 10 feet bgs). No HPAL was established for chromium VI. The chromium VI distribution in soil does not always correlate with the chromium VI distribution in groundwater (see Section 2.5.2). Chromium VI has impacted the groundwater at IR-09, which correlates with the detected concentrations in the soil at that site; however, there is little groundwater impact at IR-37, and no impacts at IR-35 where chromium VI is also detected in soil. Previous remedial actions have addressed the concentrations of chromium VI in soil. However, the Navy will investigate the area at the Pickling and Plate Yard where field test kit results indicated the possibility of residual chromium VI in soil.

Lead

Lead is a naturally occurring metal associated with bedrock of the Hunters Point Shear Zone, but it also was used in various forms as part of shipyard operations — for example, as a component in paint. Figures 2-21 and 2-22 show analytical results for lead in soil samples at Parcel D collected from the near-surface and the subsurface, respectively. Lead was detected at a frequency of greater than 85 percent at both depth intervals. The distribution of lead is widespread, indicating a ubiquitous distribution of this metal at Parcel D in both depth intervals. About 35 percent of the detected lead results in the near-surface and 18 percent of the detected lead results in the subsurface depth interval exceeded the HPAL (see Tables 2-6 and 2-7). The depiction of samples exceeding the HPAL as red dots on Figures 2-21 and 2-22 appears greater than the 35 and 18 percent calculated for near-surface and subsurface samples. This discrepancy is because a single location shown on the figure may reflect several samples at multiple depths. If any of these results exceeds the HPAL, the figure will show a red dot at that location. These results indicate elevated concentrations of lead in soils at Parcel D, with higher concentrations detected in shallower soils. Based on the results of the HHRA, remedial action is planned to address lead in soil at concentrations above remediation goals.

Manganese

Manganese is a naturally occurring metal associated with bedrock of the Hunters Point Shear Zone. Figures 2-23 and 2-24 show analytical results for manganese in soil samples at Parcel D collected from the near-surface and the subsurface, respectively. Manganese was detected at a frequency of greater than 99 percent at both depth intervals (see Tables 2-6 and 2-7). These frequencies of detections in both depth intervals indicate that manganese is ubiquitous with a widespread distribution of this metal at Parcel D. About 17 percent of the detected manganese results in the near-surface depth interval and about 9.5 percent of the detected manganese results in the subsurface depth interval exceeded the HPAL (see Tables 2-6 and 2-7). These results indicate elevated concentrations of manganese in soils at Parcel D, with higher concentrations detected in shallower soils. Although Figures 2-23 and 2-24 indicate some areas with a group of samples showing manganese concentrations exceeding the HPAL, these areas do not correlate with potential unacceptable risk areas based on exposure to this metal. In addition, the concentrations and associated sampling locations do not appear related to a release from previous industrial activities at Parcel D. However, based on the results of the HHRA, remedial action is planned to address manganese in soil above remediation goals.

2.5.1.2 Characterization of VOCs in Soil

Soil samples have been collected and analyzed for 68 individual VOCs at Parcel D. Table 2-8 presents the statistical information for each VOC for soil samples that were collected from the near-surface; Table 2-9 presents the statistical information for each VOC for soil samples collected from the subsurface. These tables show the frequencies of detection for each analyte. Forty of the 68 VOCs were consistently not detected for both depth intervals, and only 26 of the 68 VOCs were detected in one or more samples from either of the depth intervals.

Toluene was detected at the greatest frequency of approximately 13 percent for soil samples collected from the near-surface (see Table 2-8). None of the other VOCs in near-surface soils was detected at a frequency greater than 7 percent. The maximum detected concentration of VOCs for all of the soil samples in the near-surface was total xylenes, at 3 mg/kg.

Carbon disulfide was detected at the greatest frequency of approximately 13 percent for soil samples collected from the subsurface (see Table 2-9). None of the other VOCs in subsurface soils was detected at a frequency above 6 percent. The maximum detected concentration of VOCs for all of the soil samples in the subsurface was naphthalene, at 0.68 mg/kg.

The impacts of xylenes and naphthalene are most likely from releases of fuel products because both VOCs are common constituents of petroleum fuel products. As previously discussed, several TCRAs have removed and disposed of petroleum and petroleum-related releases in Parcel D. The maximum detected concentrations of these VOCs are low and represent residual concentrations.

The analytical data for VOCs in all soil samples collected from near-surface depths are used in the revised HHRA presented in Section 3.0. Results of the revised HHRA concluded that none of the VOCs present in soil are COCs; therefore, no further discussion of VOCs in soil is needed to assess remedial alternatives in this revised Parcel D FS report.

2.5.1.3 *Characterization of SVOCs in Soil*

Soil samples were collected and analyzed for 65 individual SVOCs at Parcel D. Table 2-10 presents the statistical information for each of the SVOCs for soil samples that were collected from the near-surface; Table 2-11 presents the statistical information for each of the SVOCs for soil samples collected from the subsurface. These tables show the frequency of detection for each analyte. Thirty-five of the 65 SVOCs were not detected in soil samples from either depth, leaving only 30 of the 65 SVOCs that were detected in 1 or more sample from either of the depths.

Benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were the only SVOCs detected at a frequency greater than 10 percent for soil samples collected from the near-surface (see Table 2-10). The maximum detected concentration of an SVOC for all of the soil samples from the near-surface was bis(2-ethylhexyl)phthalate, at 18 mg/kg.

Only benzo(a)pyrene, fluoranthene, phenanthrene, and pyrene were detected at frequencies greater than 10 percent for soil samples collected from the subsurface (see Table 2-11). The maximum detected concentration for all of the soil samples from the subsurface was pyrene at 13 mg/kg.

The analytical data for SVOCs for all soil samples collected from near-surface depths are used in the revised HHRA presented in Section 3.0. Results of the revised HHRA identified two COCs: benzo(a)pyrene and benzo(b)fluoranthene that contribute the greatest percentage of risk from the SVOC analyte group.

The calculated acceptable risk for an individual SVOC based on the HHRA results for Parcel D is often less than the minimum detection limit reported from the laboratory using standard EPA analytical methods. Therefore, figures and tables prepared for this section show PAH concentrations that exceeded the laboratory reporting limit of 0.33 mg/kg in soils as a screening level, although qualified concentrations of these chemicals below the laboratory reporting limit are reported and shown on the figures as detections. Figures 2-25 and 2-26 presents the distribution of detected benzo(a)pyrene at the two depth intervals, and also shows the distribution of this PAH above the laboratory reporting limit. Figures 2-27 and 2-28 presents the distribution of detected benzo(b)fluoranthene at the two depth intervals, and also shows the distribution of this PAH above the laboratory reporting limit. These two SVOCs are further discussed because they are the main risk drivers from the HHRA for the chemical group of SVOCs.

Benzo(a)pyrene

Table 2-10 and 2-11 show similar frequencies of detections of benzo(a)pyrene in near-surface and subsurface soil, at 7.66 percent and 10.46 percent, respectively. Similarly, the maximum concentrations of this PAH are nearly the same, at 4.1 and 4.2 mg/kg in the two soil intervals. These data indicate a similar concentration of benzo(a)pyrene in both the near-surface and subsurface soils at Parcel D.

Figures 2-25 and 2-26 represent the distribution of benzo(a)pyrene in the two soil depth intervals. These maps show that concentrations of this PAH above the laboratory reporting limit of 0.33 mg/kg occur at sites IR-16, IR-17, IR-33 north, IR-35, IR-44, and IR-55; however, further evaluations of benzo(a)pyrene in the HHRA (see Section 3.0 and Appendix B) indicate that concentrations of this PAH are also a risk to human health at sites IR-34 and IR-70. These areas may be associated with releases of PAHs, including benzo(a)pyrene, from the activities at the facility.

Benzo(b)fluoranthene

Tables 2-10 and 2-11 show similar frequencies of detections for benzo(b)fluoranthene in near-surface and subsurface soil, at 10.03 percent and 8.87 percent, respectively. The maximum concentrations of this PAH in the two soil intervals are 13 and 1.7 mg/kg, respectively.

Figures 2-27 and 2-28 represent the distribution of benzo(b)fluoranthene in the two soil depth intervals. These maps show concentrations of this PAH above the laboratory reporting limit of 0.33 mg/kg that are a risk to human health (see Section 3.0 and Appendix B) at sites IR-16, IR-17, IR-33 North, IR-33 South, IR-34, IR-35, IR-44, and near IR-55. These areas may be associated with releases of PAHs, including benzo(b)fluoranthene, from the activities at the facility.

2.5.1.4 Characterization of Pesticides, PCBs, and Cyanide in Soil

Soil samples were collected and analyzed for 21 individual pesticides, 7 PCBs, and cyanide at Parcel D. Table 2-12 presents the statistical information for pesticides, PCBs, and cyanide in soil samples collected from the near-surface. Table 2-13 presents the statistical information for each of these analytes in soil samples collected from the subsurface. Five of the 29 analytes were not detected in samples from either depth interval, leaving 24 analytes that were detected in 1 or more samples from either depth interval.

The PCB Aroclor-1260 and cyanide were the only analytes detected in near-surface soil samples at frequencies greater than 10 percent (see Table 2-12). Eight pesticides were detected at a frequency greater than 1 percent but less than 5 percent. The maximum detected concentrations of analytes for all of the soil samples in the near-surface were for Aroclor-1260, at 0.98 mg/kg, and cyanide at 2.2 mg/kg.

None of the pesticide or PCB analytes were detected at a frequency of greater than 1 percent for soil samples collected from the subsurface (see Table 2-13). Cyanide was detected at a frequency of less than 9 percent. The maximum detected concentration of these analytes in the subsurface was the concentration of the PCB Aroclor-1254, at 0.871 mg/kg. These differences in the detection frequencies and maximum concentrations between the two depth intervals indicate that these analytes were primarily released to near-surface soils and that they are relatively immobile.

The analytical data for pesticides, PCBs, and cyanide for all soil samples collected from the near-surface are used in the revised HHRA presented in Section 3.0. Results of the revised HHRA concluded that none of the pesticides, PCBs, or cyanide present in soil are COCs; therefore, no further discussion of pesticides, PCBs, or cyanide in soil is needed to assess remedial alternatives in this revised FS report.

2.5.2 Parcel D Groundwater Characterization

The following sections briefly discuss the analytical groups for which groundwater was analyzed: metals, VOCs, SVOCs, pesticides and PCBs, dioxins, radionuclide isotopes, total petroleum hydrocarbons (TPH), and groundwater quality parameters. For each analytical group, data summary tables list for the A-aquifer and B-aquifer various statistics, including percent detected, average concentration, and the standard deviation. The percent detected shows the frequency at which the analyte is detected. Tables 2-14 through 2-21 present the statistical data for the A-aquifer, and Tables 2-22, 2-23, and 2-24 present the statistical data for the B-aquifer. Standard deviation is a statistic that shows the variability of the data; a large standard deviation indicates that the data values differ greatly from the mean, and a small standard deviation indicates that they do not vary greatly from the mean.

The groundwater characterization in this section will only discuss the degree and extent of COCs that present a potential unacceptable risk at Parcel D in the A-aquifer. This COC list is based on those analytes from either the revised HHRA (see Section 3.1 and Appendix B) or from a screening-level evaluation with surface water criteria (see Section 3.2) that identify chemicals that pose a potential unacceptable risk to human health or a threat to the Bay.

The B-aquifer has a limited areal extent in Parcel D, as shown on Figure 2-12. The cross-section in Figure 2-7 shows the B-aquifer is separated from the A-aquifer by 25 to 45 feet of Bay Mud consisting of clay and sandy clay. Only a limited number of samples have been collected through 2004 from the three B-aquifer monitor wells that are installed at Parcel D. No remedial actions are required for the B-aquifer based on (1) the existing analytical results that show no impacts to the B-aquifer groundwater at Parcel D, and (2) the protection provided by the thick aquitard that separates the A-aquifer and the B-aquifer.

2.5.2.1 Characterization of Metals in Groundwater

Groundwater samples were collected and analyzed for 26 individual metals at Parcel D. Table 2-14 presents the statistical information for each of these metals for groundwater samples collected from the A-aquifer, and Table 2-22 presents the statistical information for the metals for B-aquifer. Results of the revised HHRA concluded that none of the metals in groundwater from either the A-aquifer or the B-aquifer are a HHRA COC; therefore, no further evaluation of metals in groundwater is needed in this revised FS report with regards to human health risk.

Chromium VI and nickel were identified as potential ecological COCs in the A-aquifer based on the surface water criteria screening (see Section 3.2). Figure 2-29 shows the extent of the chromium VI groundwater contamination based on the June 2004 data, and the extent of the nickel contamination based on the February 2001 data. These data are the most recent results used in the data set for this revised FS report for the wells that showed elevated concentrations of these two COCs.

Chromium VI is found as a plume defined by five wells in the northwestern portion of Parcel D. Four of these wells were sampled in June 2004, and the other well in this plume (IR09PPY1) was sampled in February 2001. IR09PPY1 was sampled again in 2005, 2006 and 2007; these recent data are provided on Figure 2-29. All of the wells within this plume have a history of consistent detectable concentrations of chromium VI. This metal is also consistently detected in samples from well IR09MW35A at the northwest corner of Building 411, and in samples collected from well IR33MW61A, just east of Building 304.

Nickel is consistently found at elevated concentrations in samples collected from well IR09P043A, located within Building 411 near the northwest corner of the building. Nickel is a naturally occurring metal in the groundwater at HPS: however, the elevated concentrations of nickel at this location may indicate a release that has impacted groundwater, and may be associated with the same source as the chromium VI impacts to the groundwater.

2.5.2.2 *Characterization of VOCs in Groundwater*

Groundwater samples were collected and analyzed for 57 individual VOC analytes at Parcel D. Table 2-15 presents the statistical information for each of the VOCs for groundwater samples collected from the A-aquifer, and Table 2-23 presents the statistical information for the B-aquifer. These tables also list frequencies of detection for each of the VOCs.

Thirty-three of the VOCs were not detected in groundwater samples from the A-aquifer. The remaining 24 VOCs were detected in less than 10 percent of the samples, except for chloroform, which was detected in approximately 16 percent of the samples, methane, which was detected in approximately 45 percent of the samples, and tert-butyl methyl ether, which was detected in approximately 12 percent of the samples, although the latter two analytes were sampled fewer times. None of the VOCs were reported at concentrations greater than the surface water criteria; therefore, there are no VOCs that are considered COC from the surface water screening.

Only three VOCs were detected in groundwater samples from the B-aquifer. Although the number of samples analyzed for VOCs from the B-aquifer is small, the few number of detections and the low concentrations of the analytes detected did not warrant further sampling and analyses of groundwater from the B-aquifer at Parcel D. None of the VOCs detected in the B-aquifer presented a human health risk (see Section 3.1) or were reported at concentrations greater than the surface water criteria (see Section 3.2). As a result, no VOCs in the B-aquifer are considered COCs.

All of the VOCs detected in groundwater A-aquifer and the B-aquifer were evaluated in the revised HHRA. Eight VOCs were identified as COCs in the A-aquifer: chloroform, methylene chloride, tetrachloroethene, trichloroethene, benzene, carbon tetrachloride, naphthalene, and total xylenes. Of the eight identified COCs, only chloroform, tetrachloroethene, and trichloroethene were detected during the most recent groundwater sampling event.

Figure 2-30 shows the present-day VOC contamination in the A-aquifer groundwater at Parcel D and lists the concentrations of the three COCs detected in June 2004. Three VOC plumes have been identified, the IR-09 VOC plume, the IR-71 eastern VOC plume, and a single well VOC plume (IR44MW08A) at IR-71 western VOC plume.

The plume near monitoring well IR09MW51F is within the northern plume of chromium VI at IR-09. This VOC plume is much smaller than the plume of chromium VI and contains the COCs trichloroethene and chloroform. The IR-71 eastern VOC plume that includes wells IR70MW04A and IR71MW03A is primarily chloroform, with tetrachloroethene and trichloroethene detected only in samples from well IR71MW03A. The single well IR-71 western plume at IR44MW08A contains trichloroethene and chloroform. These two IR-71 plumes appear to be separate and stable based on all of the data from analysis of groundwater from these plume wells and from monitoring well IR33MW63A, which is between these two plumes. Well IR33MW63A has had no detectable concentrations of any of the VOCs in any groundwater samples; however, IR33MW63A has not been sampled since March 1996. The data from the plume wells and other nearby wells show little change in the plumes concentrations or locations. Based on the plume's apparent stability, and on the historical data from well IR33MW63A, it is not likely that the two plumes at IR-71 are connected.

Only the most recent groundwater data in the FS data set were evaluated in considering potential remedies. At the time of the RD, the data for the 12 most recent samples from wells that are included in the remediation will be reviewed to finalize the remedy. In addition, data from new wells (installed after 2004) will be evaluated. For example, the Navy is planning a treatability study at IR-09 that will include installing wells north of well IR09MW51F (Allied Group Joint Venture 2007).

2.5.2.3 Characterization of SVOCs in Groundwater

Groundwater samples were collected and analyzed for 67 individual SVOCs at Parcel D. Table 2-16 presents the statistical information for each of the SVOCs for groundwater samples collected from the A-aquifer. This table also lists the frequency of detection for each of the SVOCs.

Forty-six of the SVOCs were not detected in any of the groundwater samples. Eleven of the SVOCs were detected at frequencies of less than 1 percent, and the remaining 10 detected SVOCs were detected at a frequency between 1 percent and 5 percent.

All of the SVOCs detected in groundwater were evaluated in the revised HHRA. Results of the revised HHRA concluded that none of the SVOCs present in groundwater are a COC. In addition, no COCs were identified based on the surface water criteria evaluation (see Section 3.2). Because no SVOCs were identified as COCs from the surface water criteria screening, no further discussion of SVOCs in groundwater is needed to assess remedial alternatives in this revised FS report.

2.5.2.4 Characterization of Pesticides, PCBs, and Cyanide in Groundwater

Groundwater samples were collected and analyzed for 21 individual pesticides, 7 PCBs, and cyanide at Parcel D. Table 2-17 presents the statistical information for each of these analytes for groundwater samples collected from the A-aquifer. This table also lists the frequency of detection for each of the analytes.

Because no chemicals from these analyte groups were identified as COCs, no further discussion of pesticides or PCBs in groundwater is needed to assess remedial alternatives in this revised FS report.

Cyanide was detected in a grab groundwater sample at IR-22. Results for grab groundwater samples from borings were not included in the groundwater statistics or in the HHRA, as the samples do not meet the required quality assurance criteria. Cyanide has not been detected in groundwater at groundwater monitoring wells at IR-22. However, further groundwater monitoring in this area will be recommended as part of the groundwater alternatives because of the proximity of the grab groundwater sample to the Bay.

2.5.2.5 Characterization of Dioxins and Furans in Groundwater

Groundwater samples were collected and analyzed for 26 individual dioxins and furans. Table 2-18 presents the statistical information for each of these chemicals dioxin for groundwater samples collected from the A-aquifer. This table also lists the frequency of detection for each of the analytes.

Only dibenzofuran and total tetrachlorodibenzofuran were detected in groundwater samples. Results of the revised HHRA concluded that dibenzofuran and tetrachlorodibenzofuran were not identified as COCs in groundwater at Parcel D. Because no chemicals from these analyte groups were identified as COCs, no discussion of dioxins or furans in groundwater is needed to assess remedial alternatives in this revised FS report.

2.5.2.6 Characterization of Radionuclide Isotopes in Groundwater

Groundwater samples were collected and analyzed for 45 individual radionuclide isotopes. Groundwater sampling for radionuclide isotopes focused on the areas identified with potential radioactive contamination. Table 2-19 presents the statistical information for each of these isotopes for groundwater samples collected from the A-aquifer. This table also lists the frequency of detection for each isotope.

Only 6 of the 45 radionuclide isotopes were detected (see Table 2-19). The following isotopes were detected in groundwater samples: americium-241, antimony-125, radium-226, radium-228, uranium 234, and uranium-238. The revised HHRA for groundwater (see Section 3.0) and the remedial alternatives presented in this revised FS report do not address radionuclide isotopes. The statistics for these isotopes are presented for information only. The Navy is conducting a separate program to address the radionuclide contamination.

2.5.2.7 Characterization of TPH in Groundwater

Groundwater samples were collected and analyzed for TPH and other petroleum hydrocarbon ranges by a variety of methods. Table 2-20 presents the statistical information for each of the reported petroleum ranges for groundwater samples collected from the A-aquifer. This table also lists the frequency of detection for each of the compounds.

Analytical results show no detections of TPH as extractable unknown hydrocarbons, TPH as JP5 aviation fuel, TPH as kerosene, or TPH as purgeable unknown hydrocarbons.

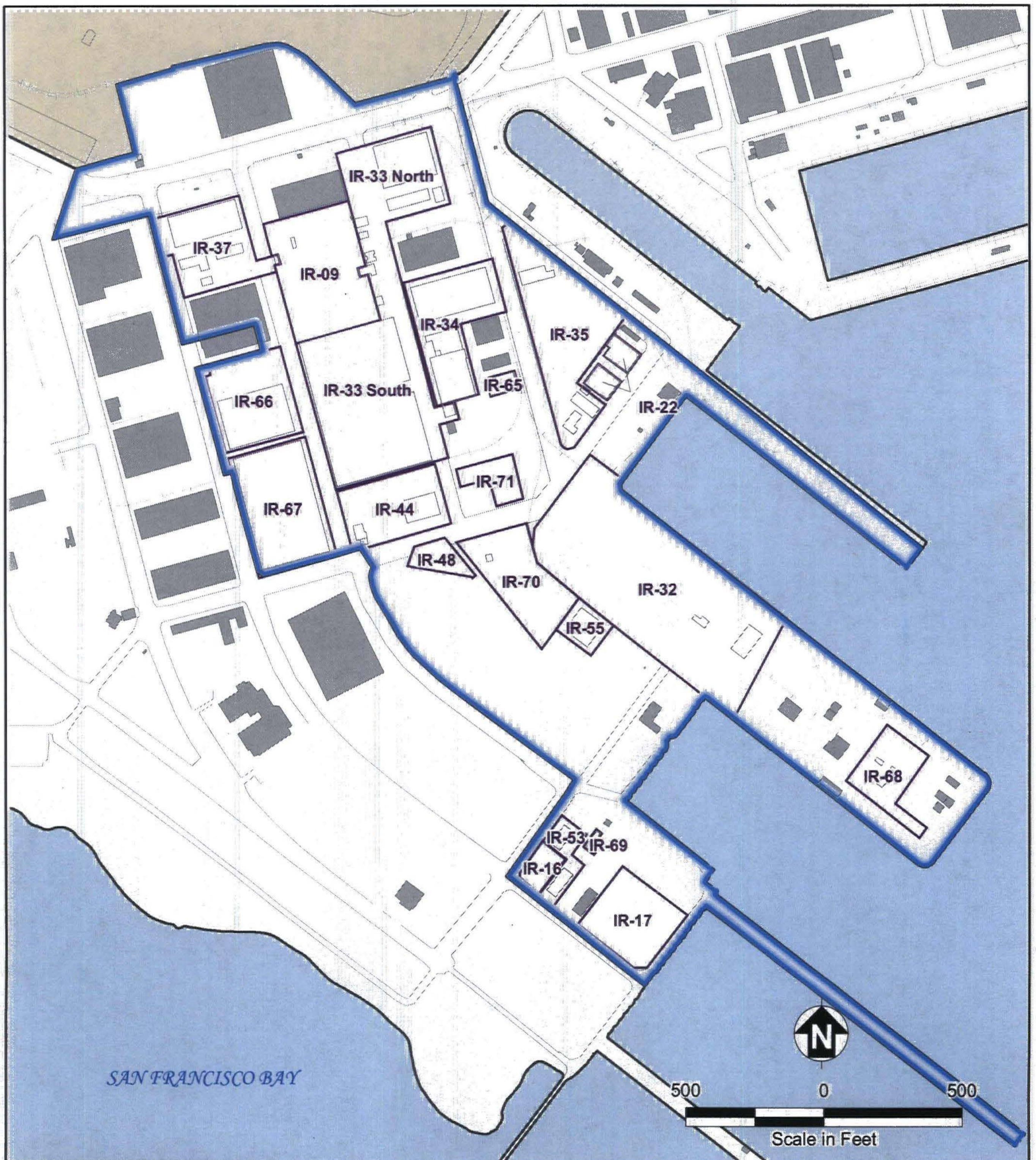
Petroleum hydrocarbon compounds are made up of many VOCs and SVOCs at varying ratios and different toxicities. Toxicity calculations and HHRAs are not commonly conducted for TPH ranges because they are a mixture of many analytes, and little or no data on the toxicity of such a mixture are known. In addition, these compounds naturally degrade and change in the environment, altering the mixture and making it difficult to analyze or predict the toxicity of a reported TPH range. However, nearly all of the samples that were analyzed for TPH were also analyzed for VOCs and SVOCs to measure the concentrations of individual constituents of the TPH compounds. These individual concentrations of VOCs and SVOCs were used in the revised HHRA (see Section 3.0) to account for the potential exposure of human receptors to petroleum compounds.

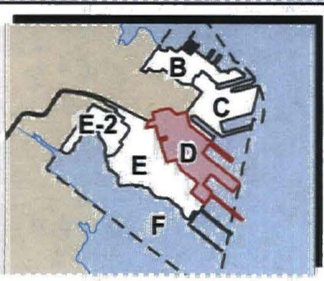
2.5.2.8 Characterization of Other Groundwater Characteristics

Groundwater samples were collected and analyzed for a variety of water quality characteristics. Table 2-21 presents the statistical information for each of these characteristics for groundwater samples collected from the A-aquifer, and Table 2-24 presents the statistical information for the B-aquifer. These data support the evaluation of beneficial use of the aquifers presented in Appendix D. In addition, groundwater characteristics may be important in evaluating certain types of groundwater remedies by identifying chemical constituents that may interfere with the remedial process such as sulfur compounds or TDS. None of these water quality characteristics are considered in the revised HHRA.

Elevated pH has been observed at one well at Parcel D. The pH readings at well IR33MW61A have exceeded 11 in four sampling events between 1996 and 2000. This elevated pH will be addressed in the groundwater alternatives.

FIGURES





Location Map

- Parcel D IR Sites
- Parcel D Boundary
- Other Parcel Boundaries
- Non-Navy Property
- Building
- Road

Note:
IR Installation Restoration

SulTech

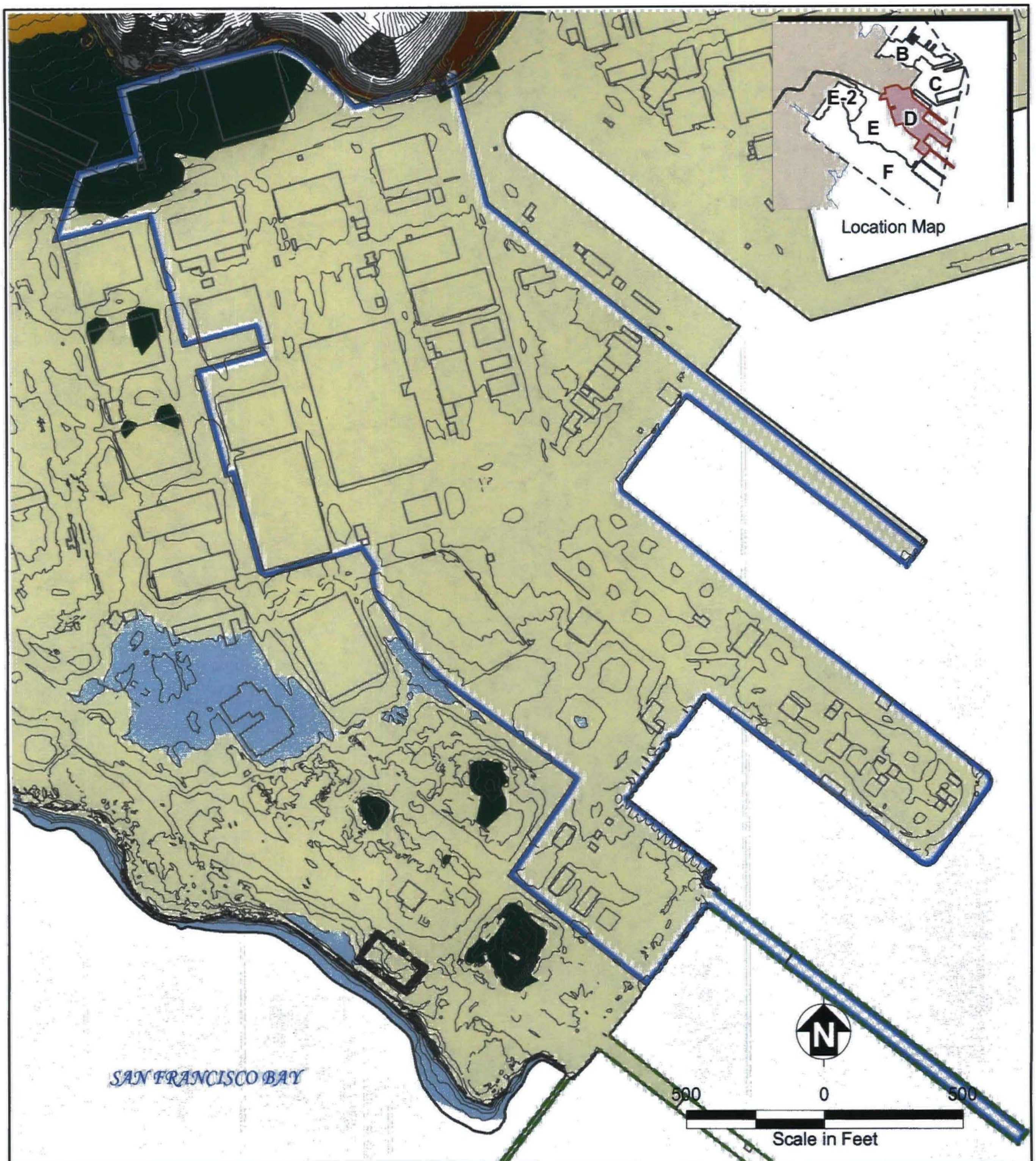
Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-1

PARCEL D IR SITES

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Parcel D IR Sites.mxd TtEMI-SF Kevin Ernst



Elevation Ranges (ft above msl)

- >50 ft
- 30-50 ft
- 25-30 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- 0-5 ft

Note:
msl Mean sea level

- Ground Surface Contours (1 Foot Interval)
- Areas with Underlying Water
- Parcel D Boundary
- Other Parcel Boundaries
- Building

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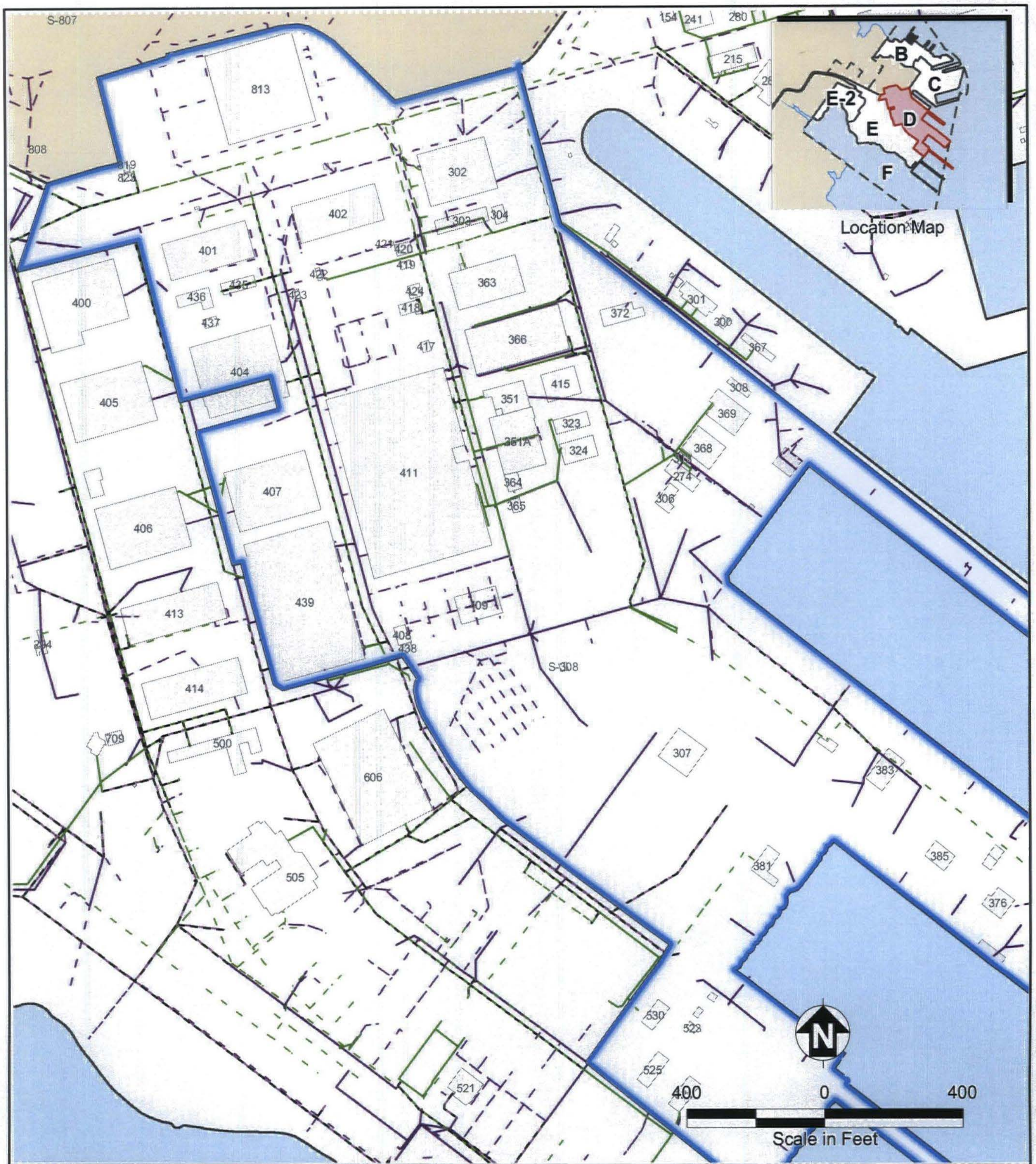
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-2

SURFACE TOPOGRAPHY AT PARCEL D

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Parcel D Topography.mxd TtEMI-SF Kevin Ernst



Sanitary Sewer Elevation Relative to Groundwater (June 2002)

- Above Groundwater
- Below Groundwater
- Unknown Elevation
- Parcel D Boundary
- Other Parcel Boundaries

Storm Drain Line Relative to Groundwater (June 2002)

- Above Groundwater
- Below Groundwater
- Unknown Elevation
- Building

Note: The Navy plans to remove the storm drain and sanitary sewer lines throughout most of HPS in 2006.

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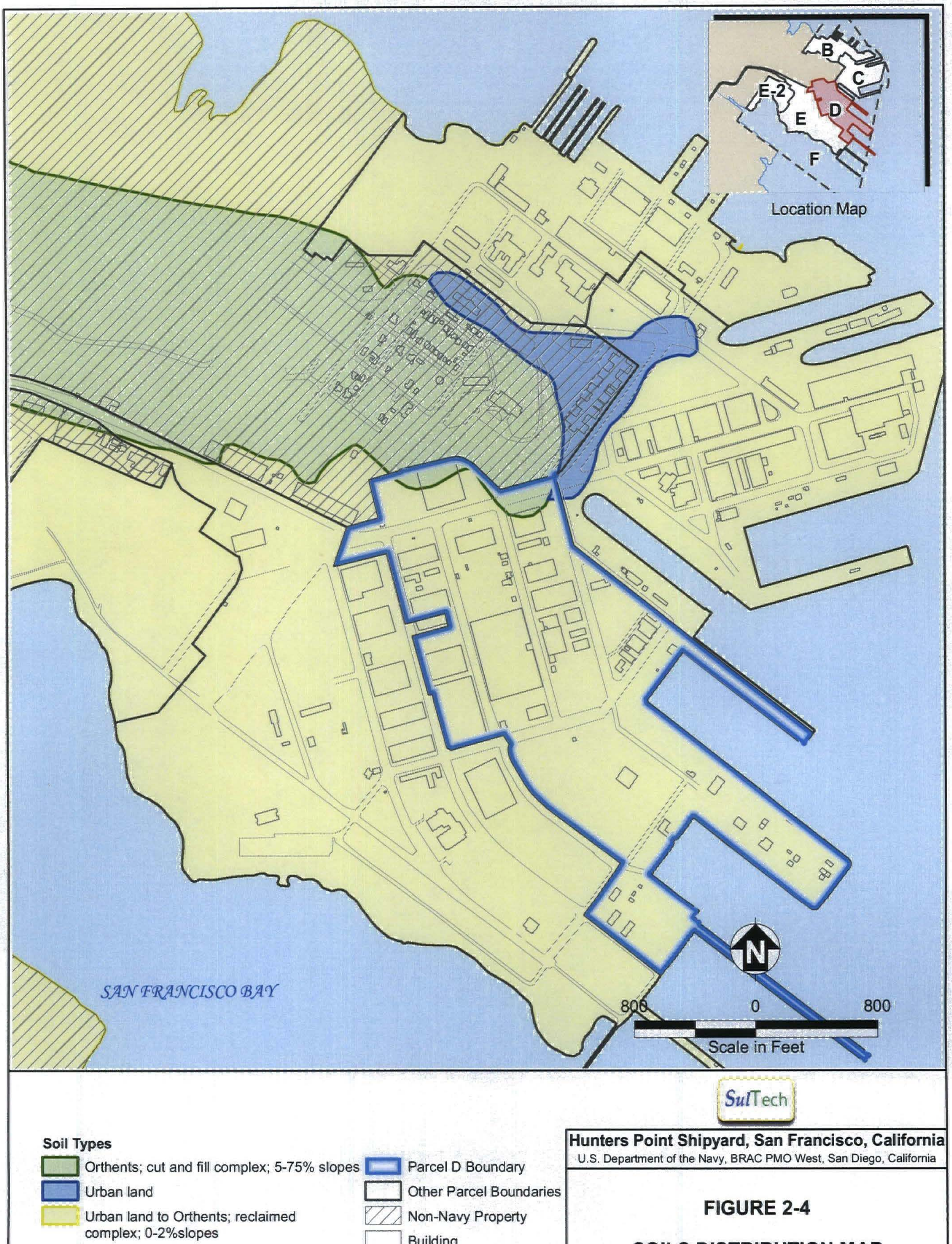
FIGURE 2-3

STORM DRAIN AND SANITARY SEWER LINE MAP

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Parcel D Storm_Sewer Lines.mxd TtEMI-SF Kevin Ernst



Hunters Point Shipyard, San Francisco, California

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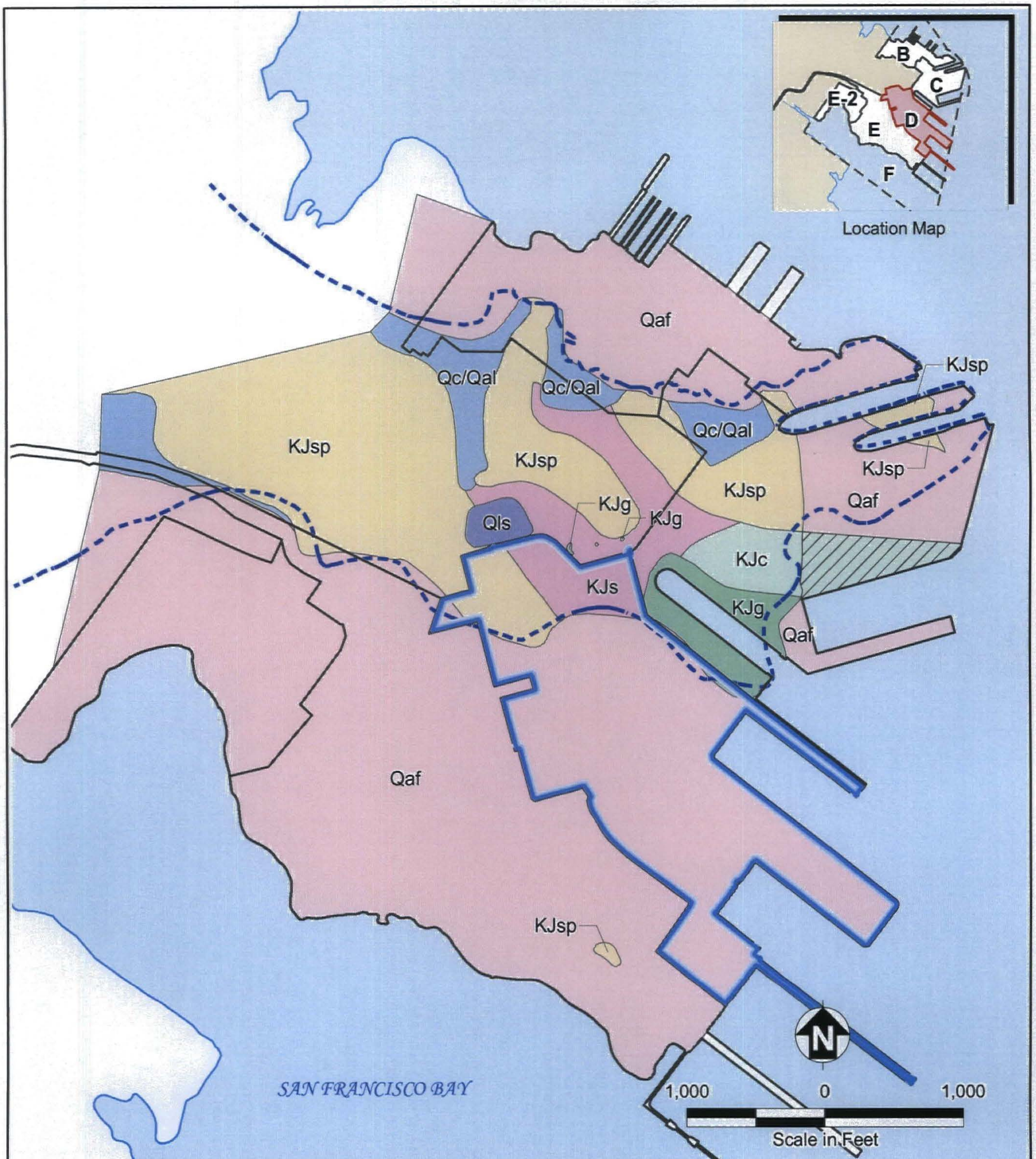
FIGURE 2-4

SOILS DISTRIBUTION MAP

Revised Feasibility Study Report for Parcel D



Geologic Characterization

(Base on Bonilla 1971 and Schlocker 1974)

- KJc-Chert interbedded with shale
- KJg-Predominantly greenstone volcanic rock (Marin Headlands terrane)
- KJs-Undifferentiated sandstone and shale
- KJsp-Serpentinite
- Qaf-Fill material
- Qc/Qal-Colluvium/alluvium
- Qls-Landslide debris zone
- Geologic Contact (added by Tetra Tech [2001])

- 1935 Shoreline
- Parcel D Boundary
- Other Parcel Boundaries

Reference:

Bonilla, M.G. 1971. "Preliminary Geologic Map of the San Francisco South Quadrangle and Part of the Hunters Point Quadrangle." *U.S. Geological Survey Miscellaneous Field Studies Map.* MG-311. 1:24,000

Schlocker, J. 1974. "Geology of the San Francisco North Quadrangle, California." *U.S. Geological Survey Professional Paper 782.* Page 109.

Tetra Tech EM Inc. 2001. "Evaluation of Ambient Manganese Conditions, Hunters Point Shipyard, San Francisco, California."

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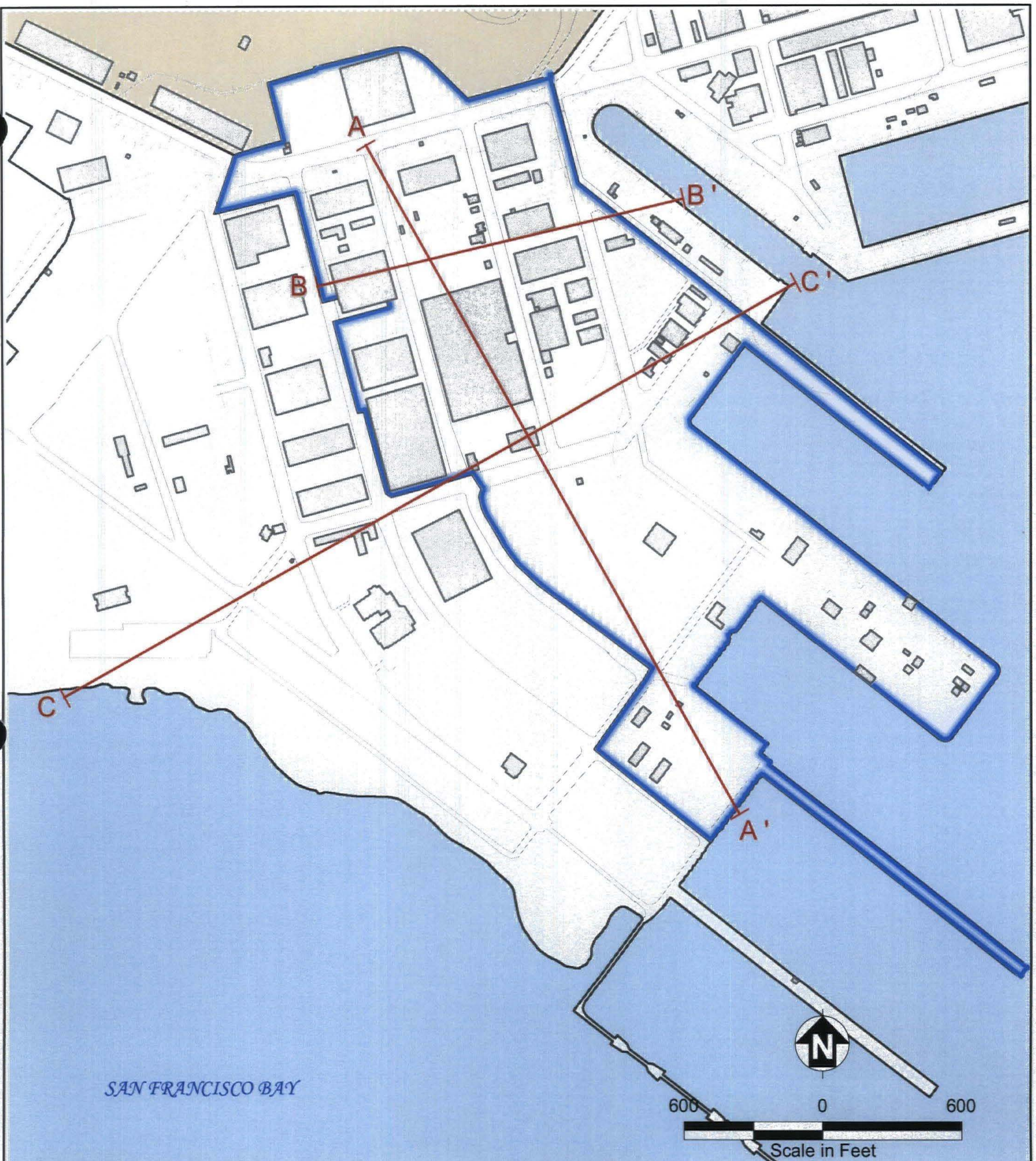
FIGURE 2-5

SURFICIAL GEOLOGY

Revised Feasibility Study Report for Parcel D



A A'
Cross-Section Line
Parcel D Boundary
Other Parcel Boundaries
Non-Navy Property
Building
Road
Rail Line

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FIGURE 2-6

HYDROGEOLOGICAL CROSS-SECTION LOCATION MAP

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Cross-section locations.mxd TtEMI-SF Kevin Ernst

PARTIALLY SCANNED OVERSIZE ITEM(S)

See document # 2253535
for partially scanned image(s).

FIGURE 2-7

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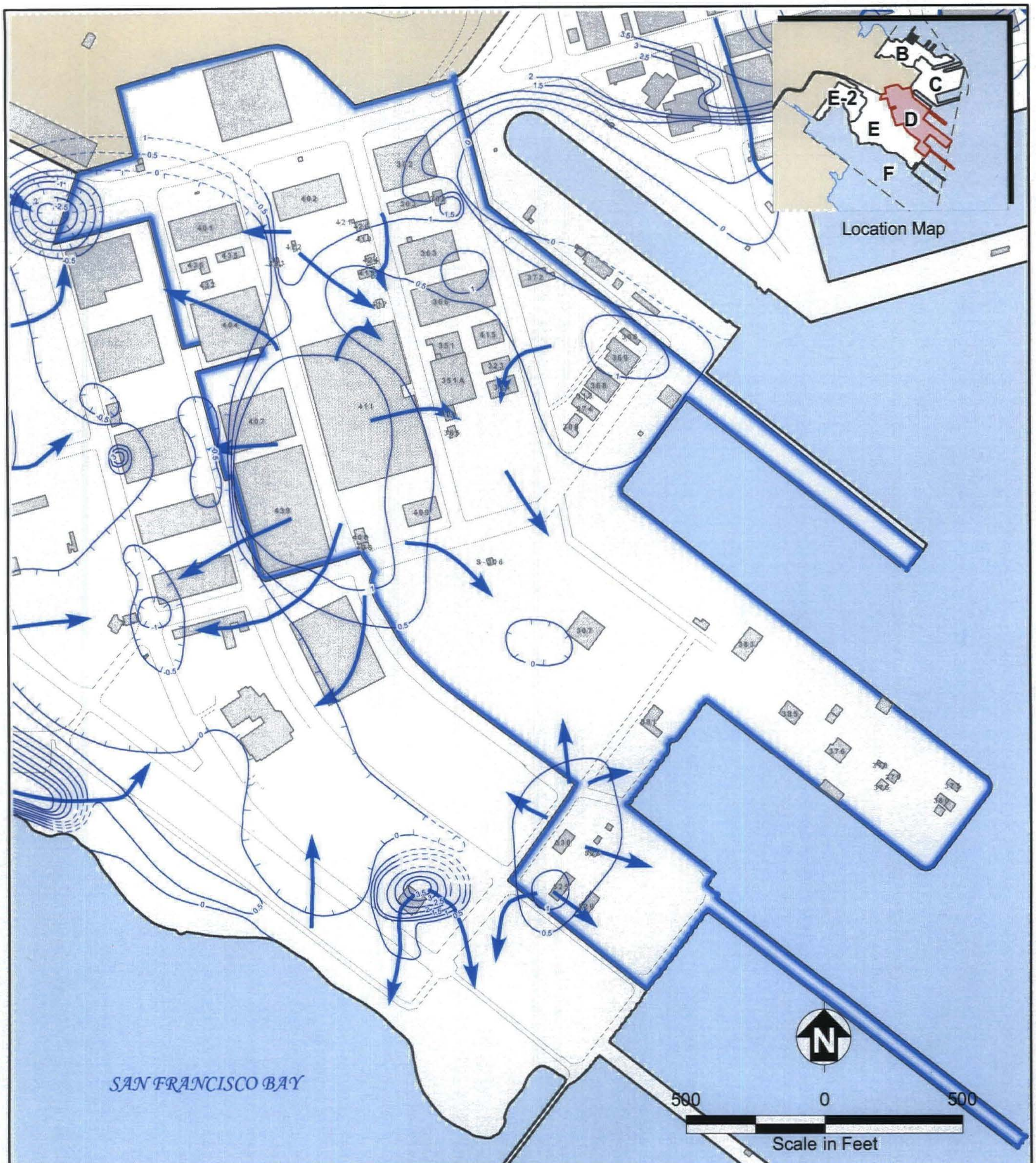

A-Aquifer Groundwater Contours (Phase III GDGI, February 2002; feet msl); dashed where inferred; hatched lines indicate depressions

A-Aquifer Flow Direction

Parcel D Boundary

Parcel Boundary

Non-Navy Property

Building

Note:
msl Mean sea level

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FIGURE 2-8
A-AQUIFER GROUNDWATER CONTOURS AT PARCEL D, 2002

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\A-Aquifer contours_Parcel D.mxd TtEMI-SF Kevin Ernst

PARTIALLY SCANNED
OVERSIZE ITEM(S)

See document # 2253535
for partially scanned image(s).

FIGURE 2-9

For complete hardcopy version of the oversize document
contact the Region IX Superfund Records Center

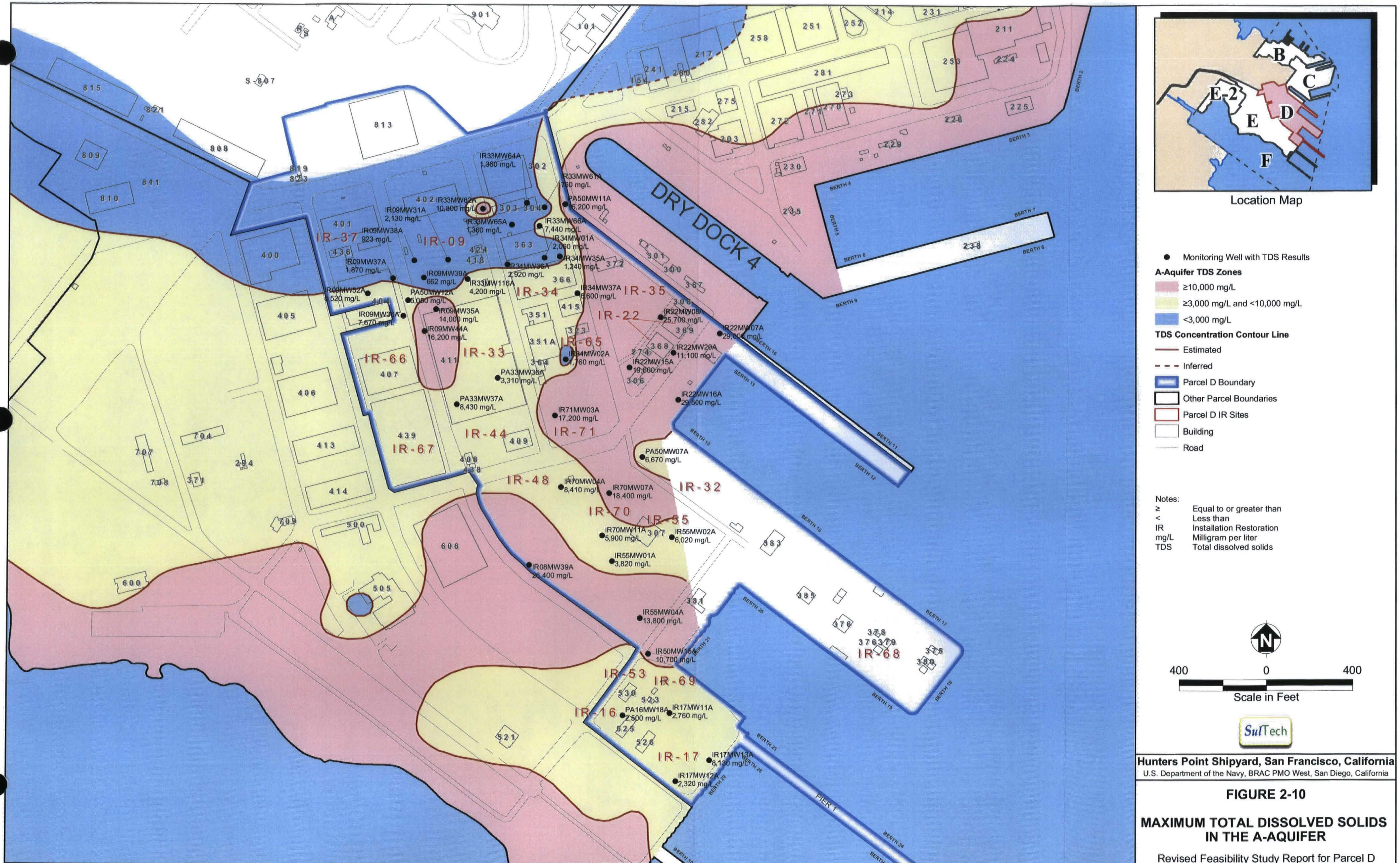

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FIGURE 2-10

MAXIMUM TOTAL DISSOLVED SOLIDS IN THE A-AQUIFER

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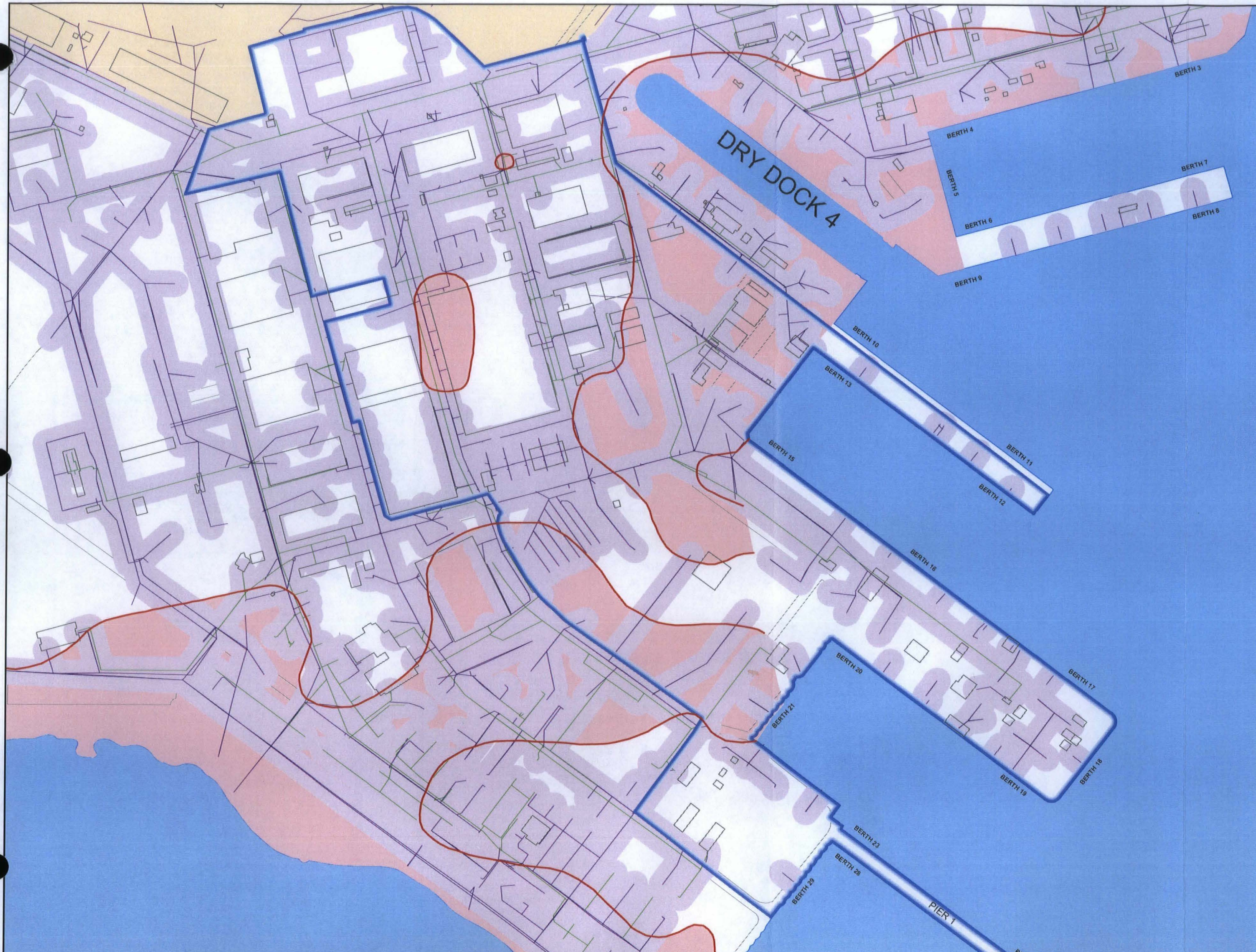
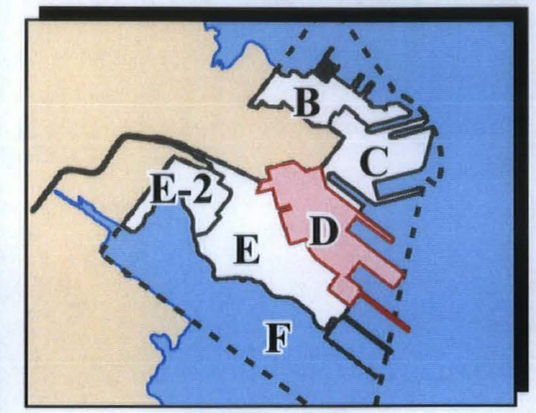
2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Groundwater\parcel d_max TDS_a-aquifer.mxd TtEMI-SF Kevin Ernst





Location Map

Sanitary Sewer Line
Storm Line
Areas Within 50 Feet of Sanitary Sewer or Storm Lines
TDS ≥10,000 mg/L
Parcel D Boundary
Other Parcel Boundaries
Non-Navy Property
Building
Road

Notes:

≥	Greater than or equal to
mg/L	Milligrams per liter
TDS	Total dissolved solids
UNKW	Unknown

N

350 0 350

Scale in Feet

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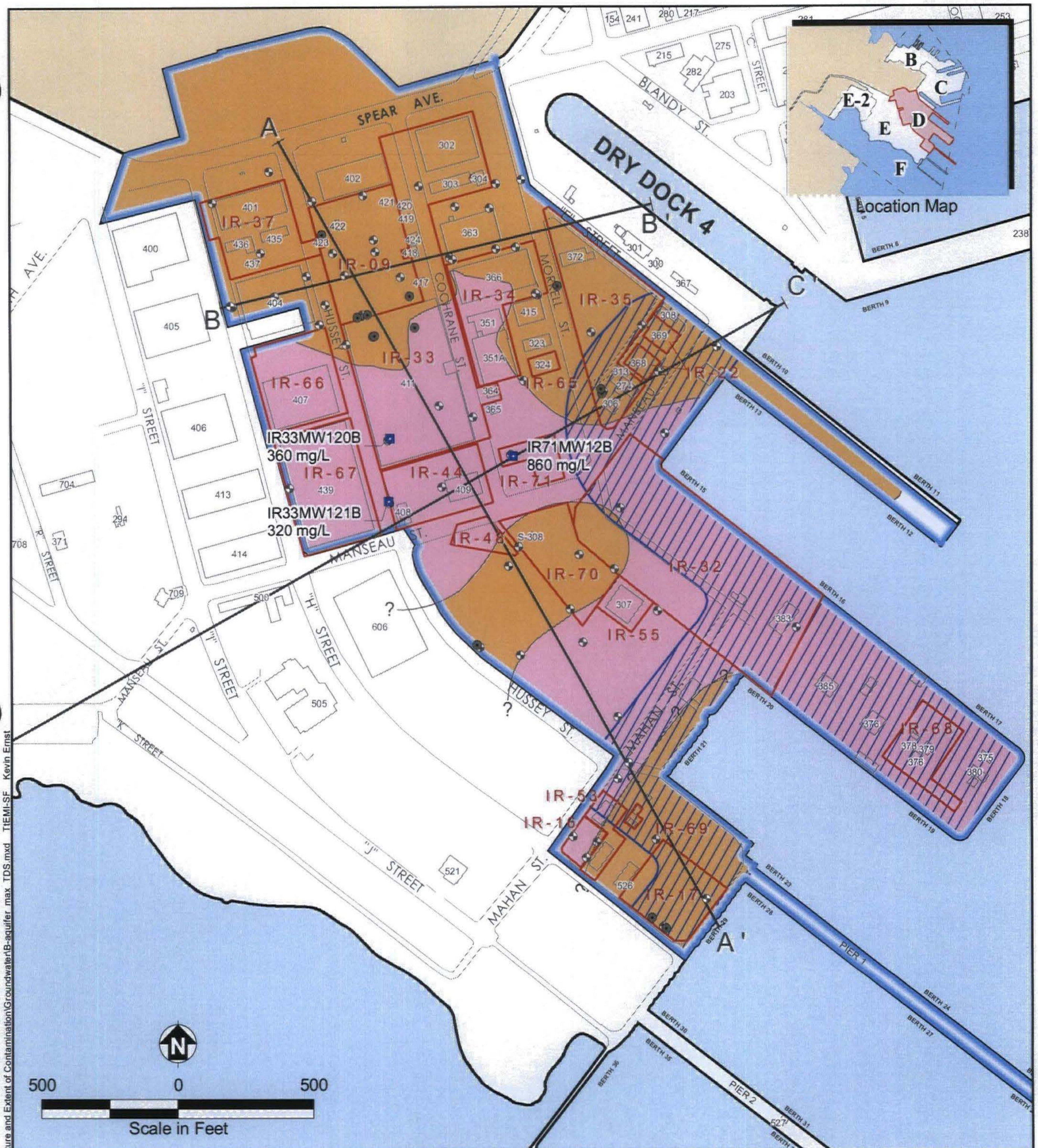
FIGURE 2-11
AREAL DISTRIBUTION OF FACTORS LIMITING DRINKING WATER BENEFICIAL USE OF A-AQUIFER GROUNDWATER PER FEDERAL CRITERIA

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Groundwater\beneficial use limits_parcel d.mxd TtEMI-SF Kevin Ernst



- A-Aquifer Well
- B-Aquifer Well
- Piezometers
- B-Aquifer Under Bay Mud
- B-Aquifer Absent (queried where uncertain)
- Tidal Influence Zone
- Parcel D Boundary
- Other Parcel Boundaries
- Parcel D IR Site Boundaries
- Non-Navy Property
- Building
- Cross-Section Line (see Figure 2-3)
- Road

Notes:

IR Installation Restoration

mg/L milligram per liter

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FIGURE 2-12

MAXIMUM TOTAL DISSOLVED SOLIDS IN THE B-AQUIFER

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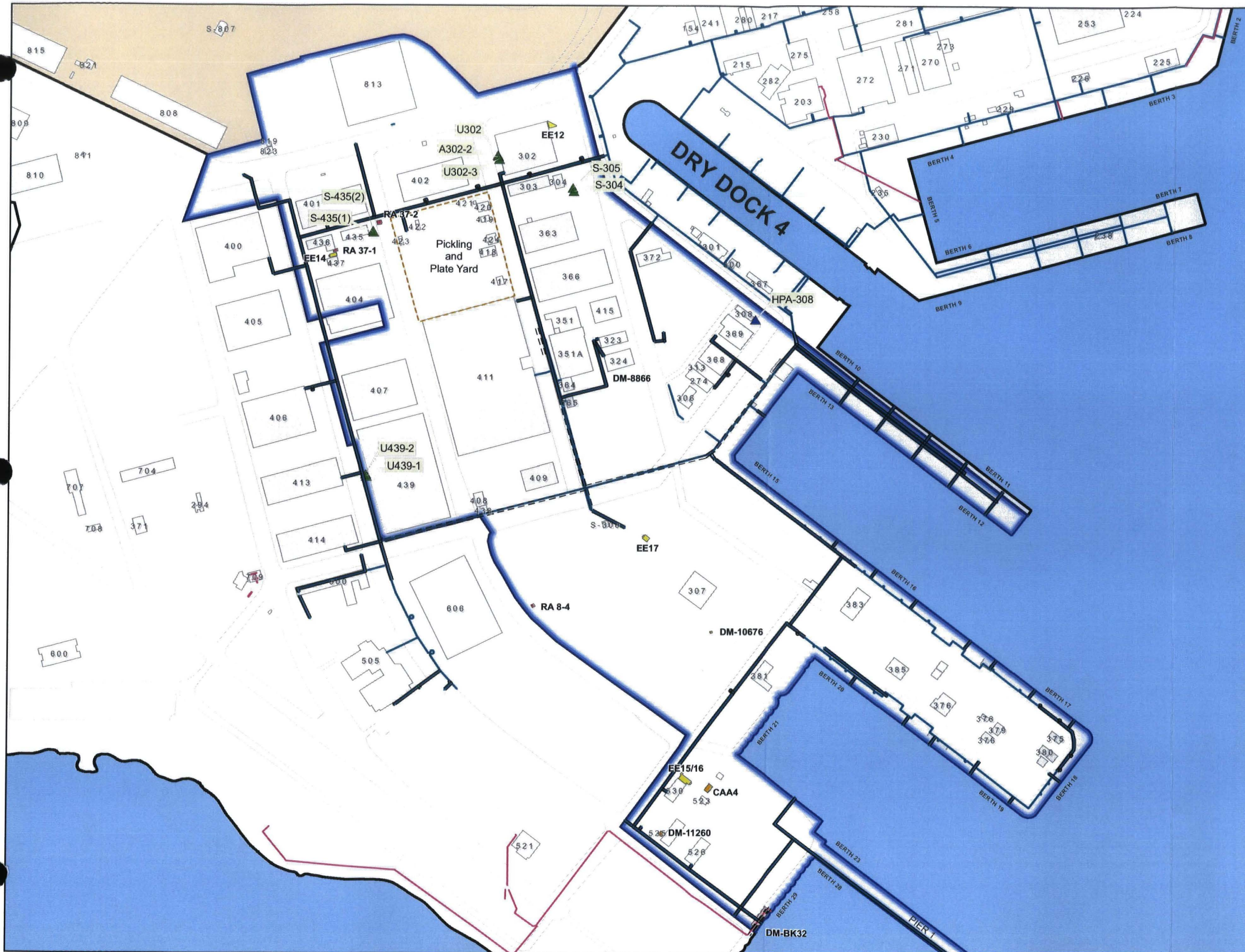
2005-11-28 V:\Hunters Point\Projects\Parcel D FS\Nature and Extent of Contamination\Groundwater\B-aquifer_max_TDS.mxd TtEMI-SF Kevin Ernst



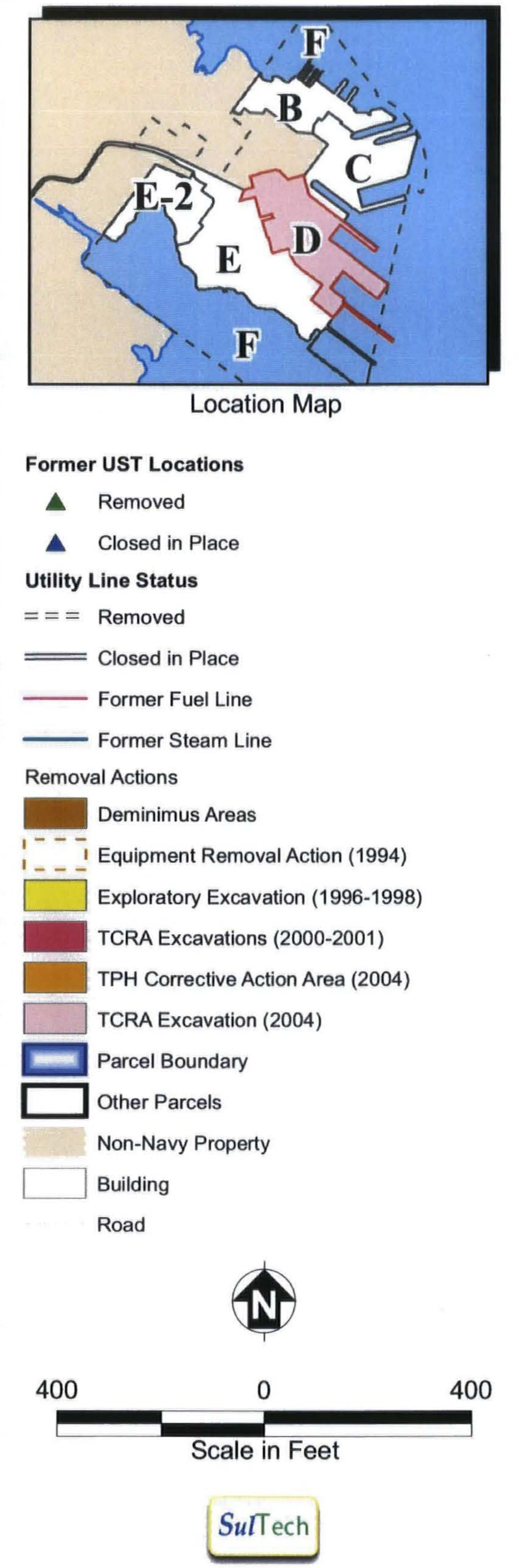


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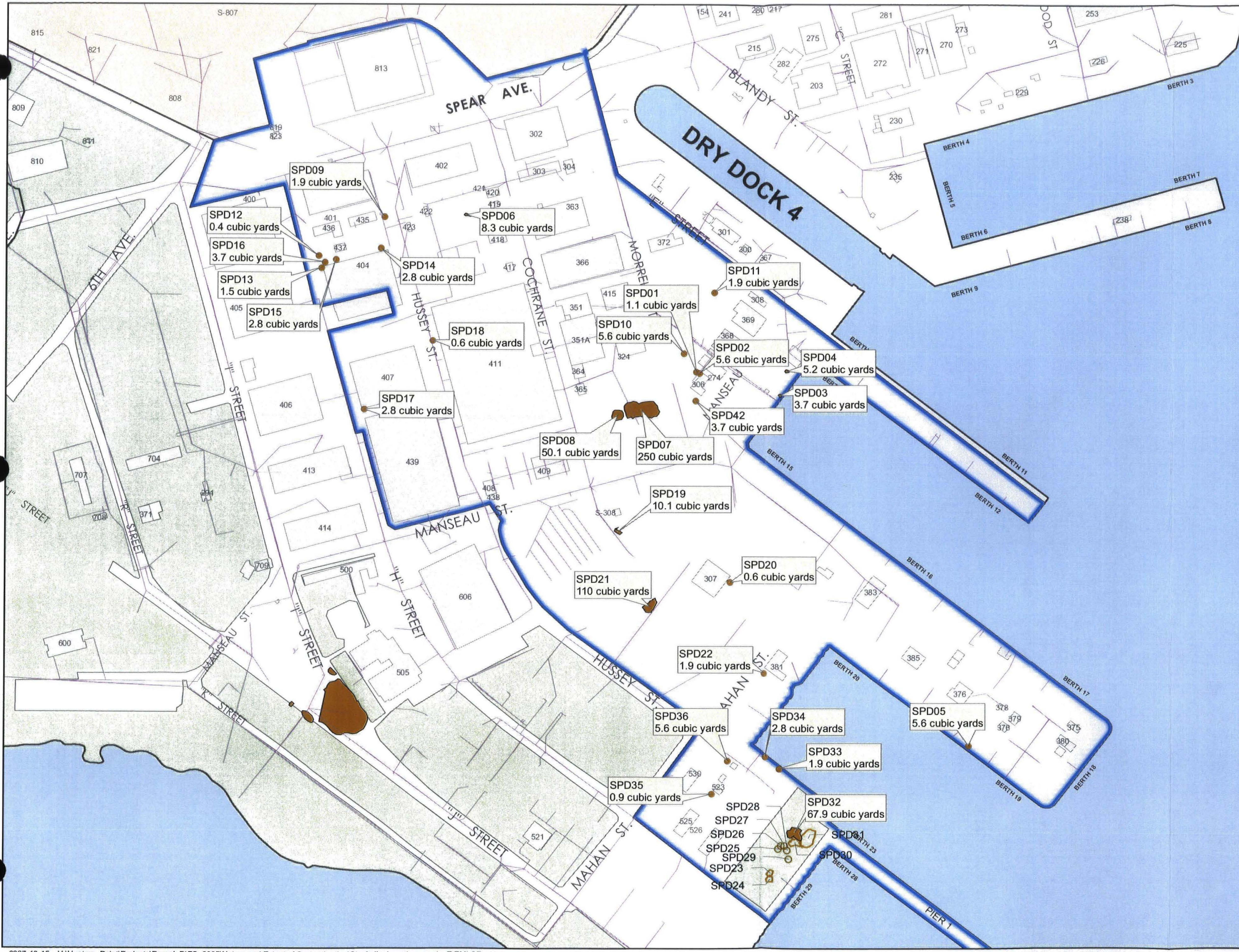
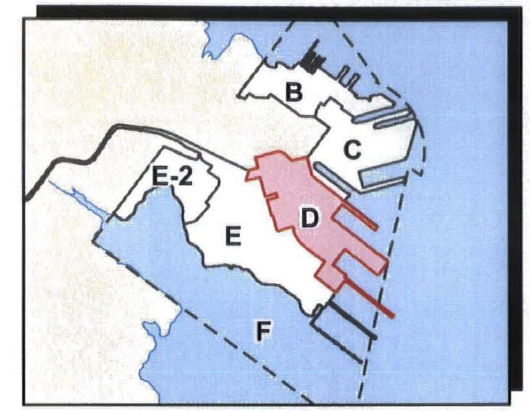
FIGURE 2-13

FORMER USTs, UTILITY LINES, AND REMOVAL ACTION AREAS MAP

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Tanks_and_Excavations.mxd TtEMI-SF Kevin Ernst





Location Map

Storm Drain Line
Existing Stockpile
Removed Stockpile
Parcel D Boundary
Other Parcel Boundaries
Non-Navy Property
Building
Paved Surface
Unpaved Surface

Notes:

CAA Corrective action area
EE Exploratory excavation
RA Removal action
SPD Stockpile, Parcel D

400 0 400
Scale in Feet

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FIGURE 2-14

STOCKPILES AND STORM DRAIN LINES LOCATION MAP

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Stockpile_Locations.mxd TtEMI-SF Kevin Ernst

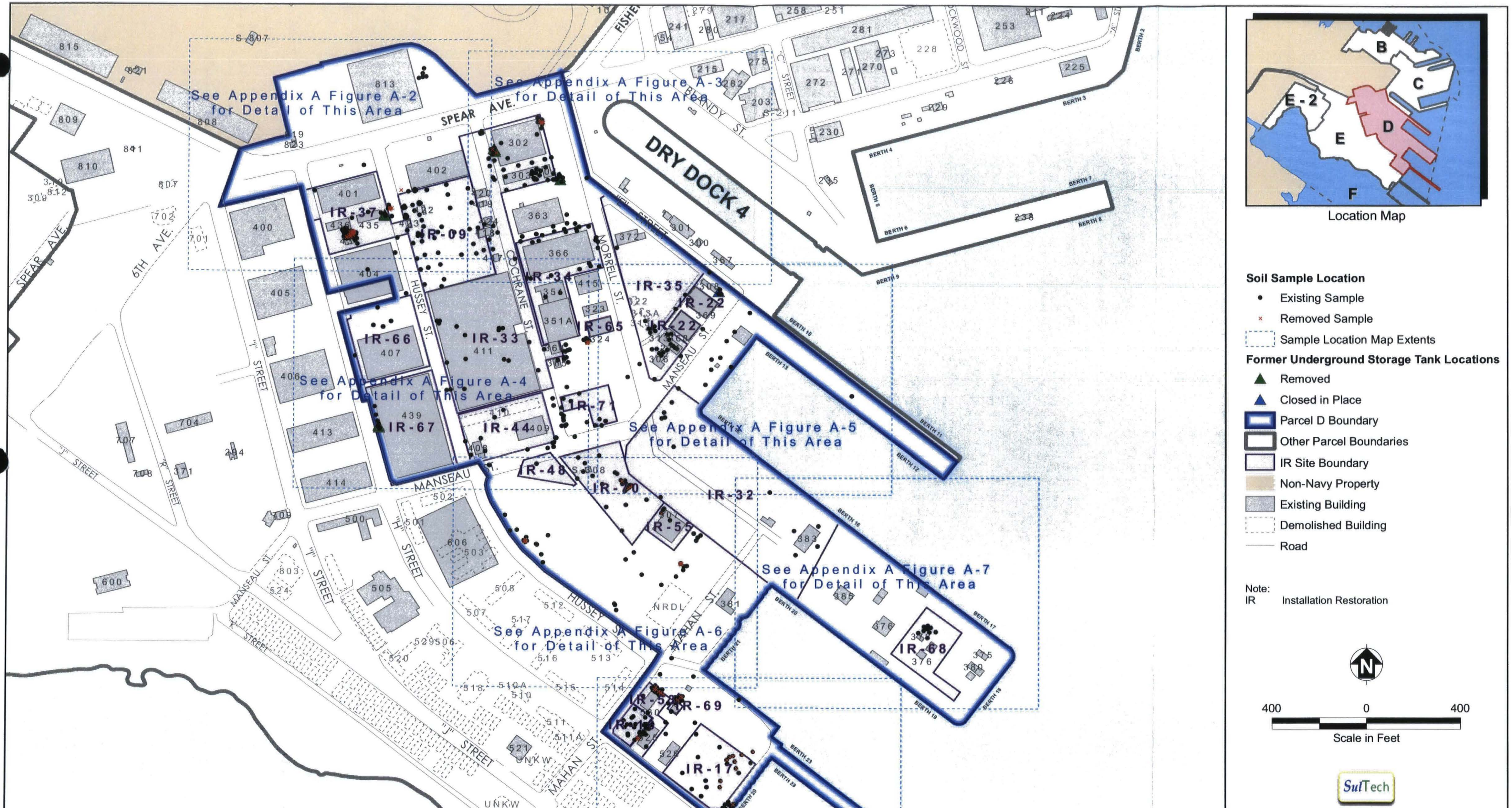

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FIGURE 2-15

PARCEL D SOIL SAMPLE LOCATIONS

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Sample Location Maps\Soil Samples\Soil sample locations index map.mxd TtEMI-SF Kevin Ernst

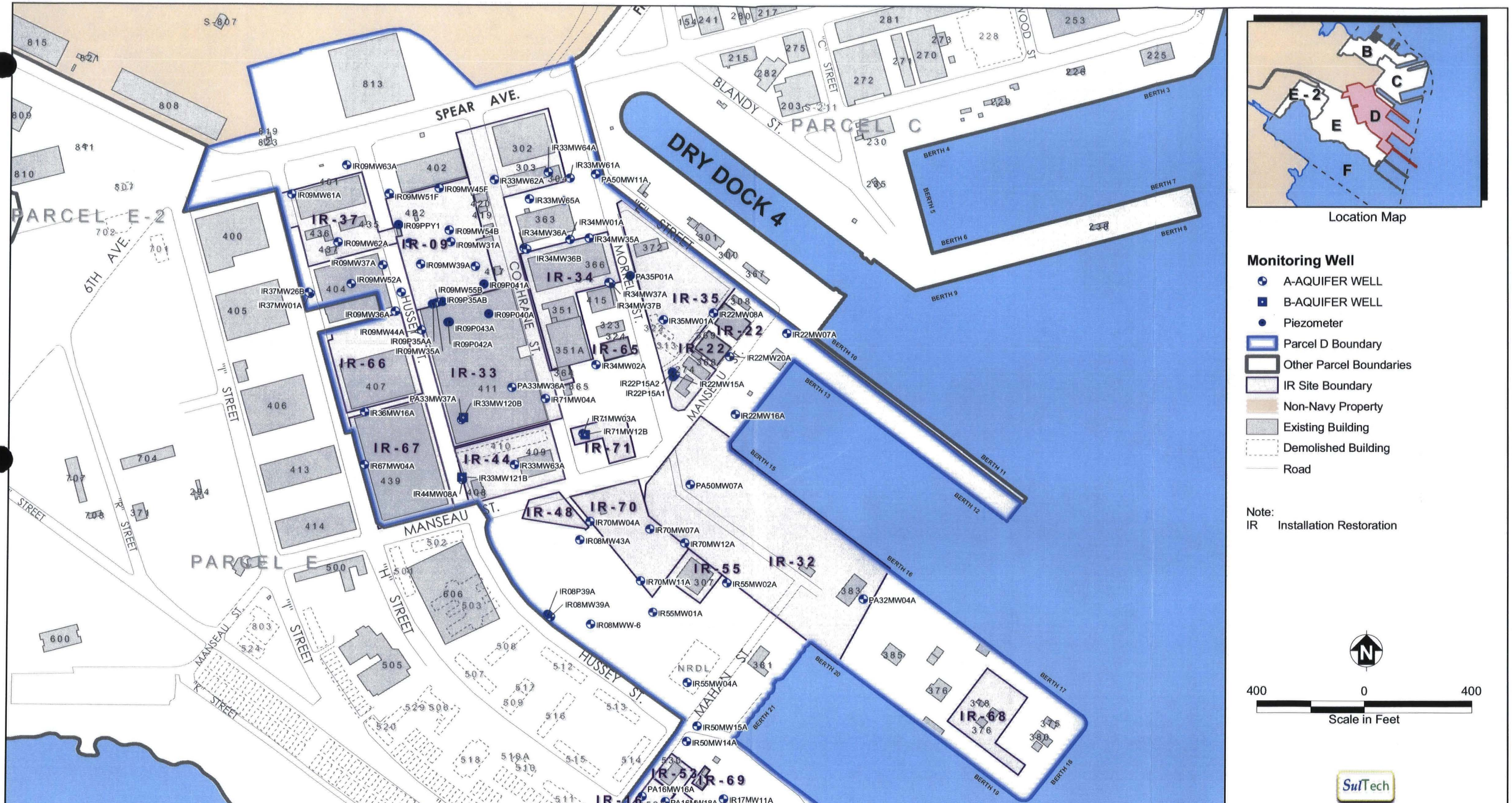

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FIGURE 2-16

PARCEL D GROUNDWATER SAMPLE LOCATIONS

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Sample Location Maps\Groundwater Samples\Groundwater sample locations map.mxd TtEMI-SF Kevin Ernst

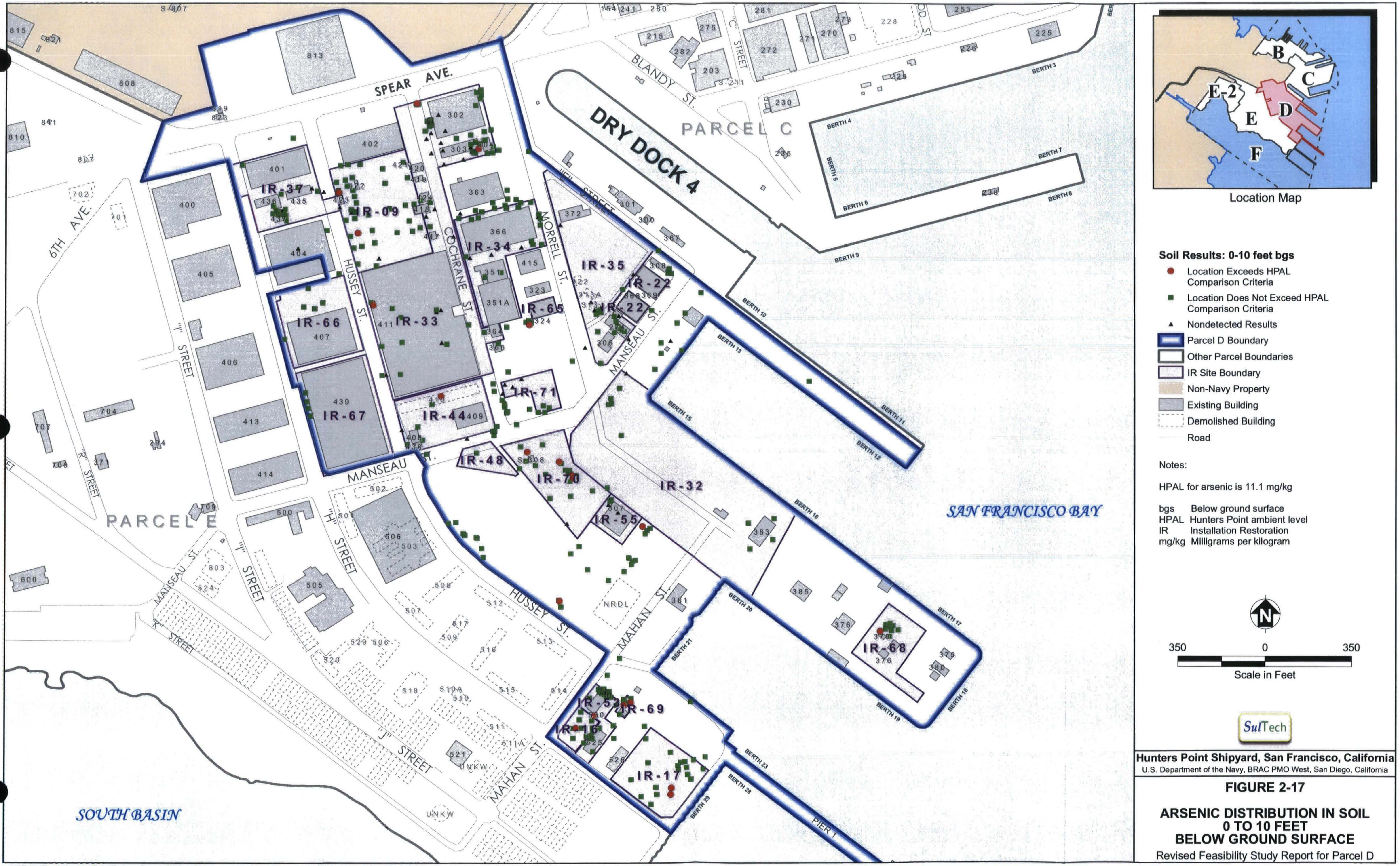

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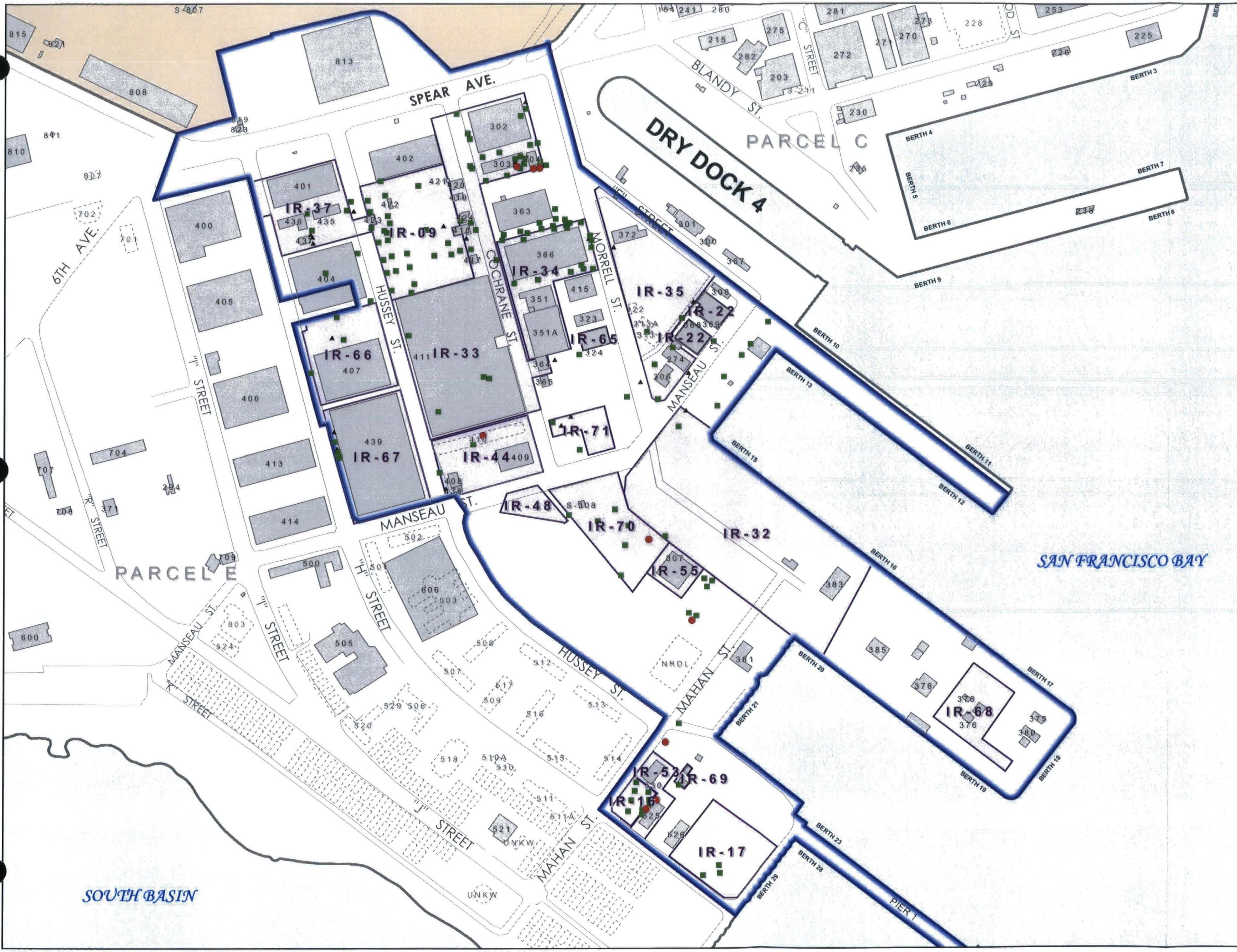
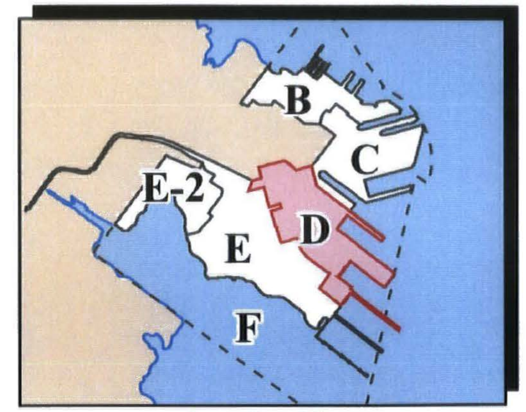
FIGURE 2-17

ARSENIC DISTRIBUTION IN SOIL 0 TO 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Arsenic in soil_0-10ft.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: >10 feet bgs

- ● Location Exceeds HPAL Comparison Criteria
- ■ Location Does Not Exceed HPAL Comparison Criteria
- ▲ Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

HPAL for arsenic is 11.1 mg/kg

>	Greater than
bgs	Below ground surface
HPAL	Hunters Point ambient level
IR	Installation Restoration
mg/kg	Milligrams per kilogram

N

350 0 350

Scale in Feet

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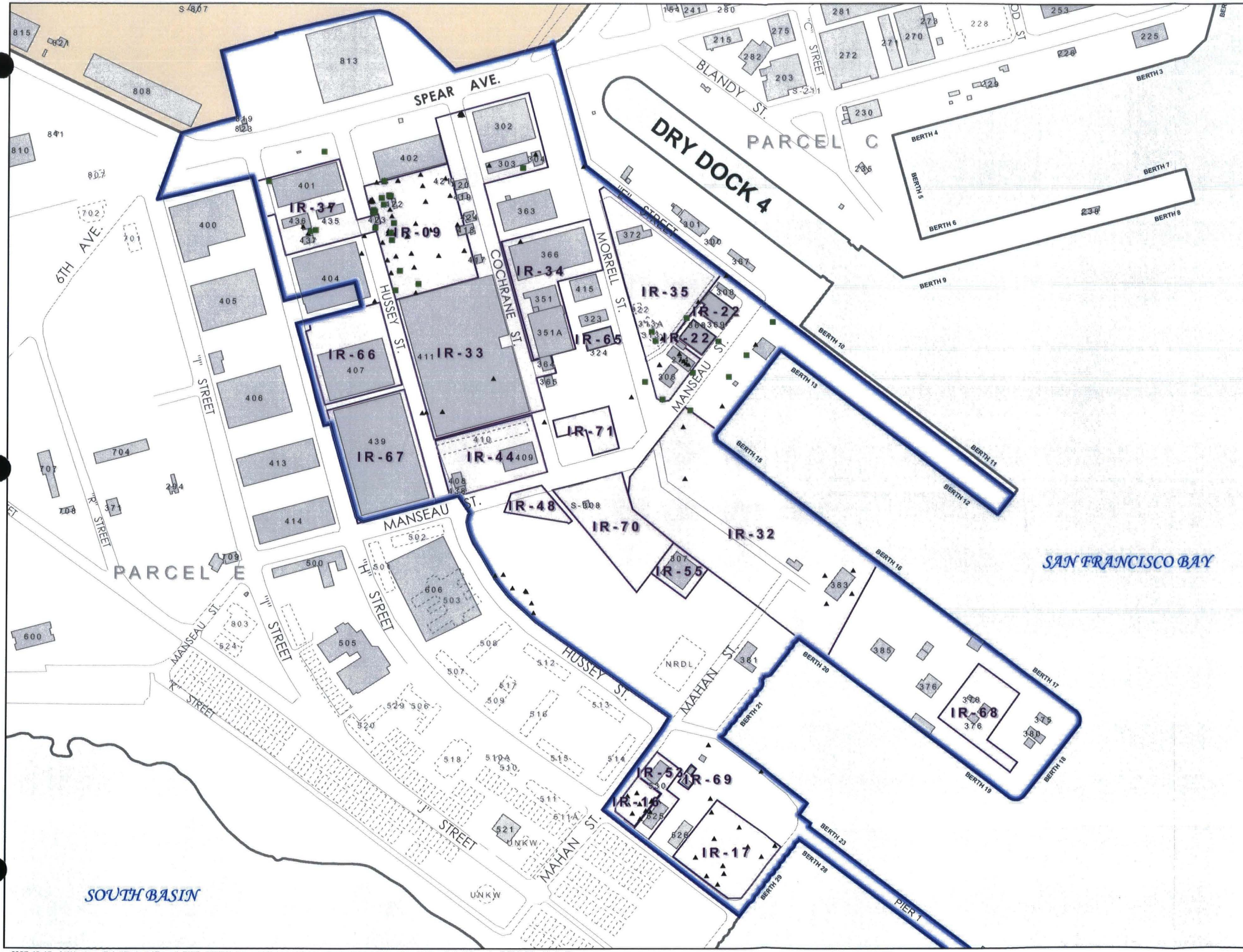
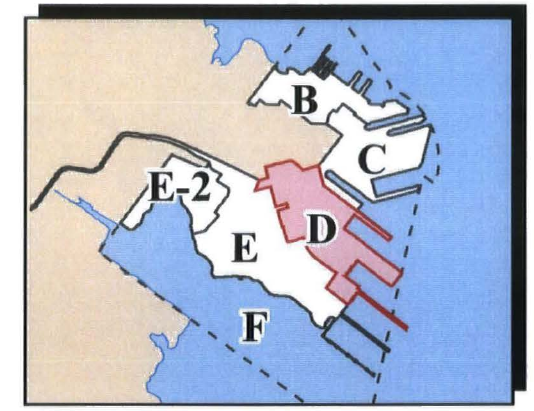
FIGURE 2-18

ARSENIC DISTRIBUTION IN SOIL GREATER THAN 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Arsenic in soil_gt10ft.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: 0-10 feet bgs

- Detected Results
- Nondetected Results
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

bgs	Below ground surface
IR	Installation Restoration
mg/kg	Milligrams per kilogram
PRG	Preliminary remediation goal

N

350 0 350

Scale in Feet

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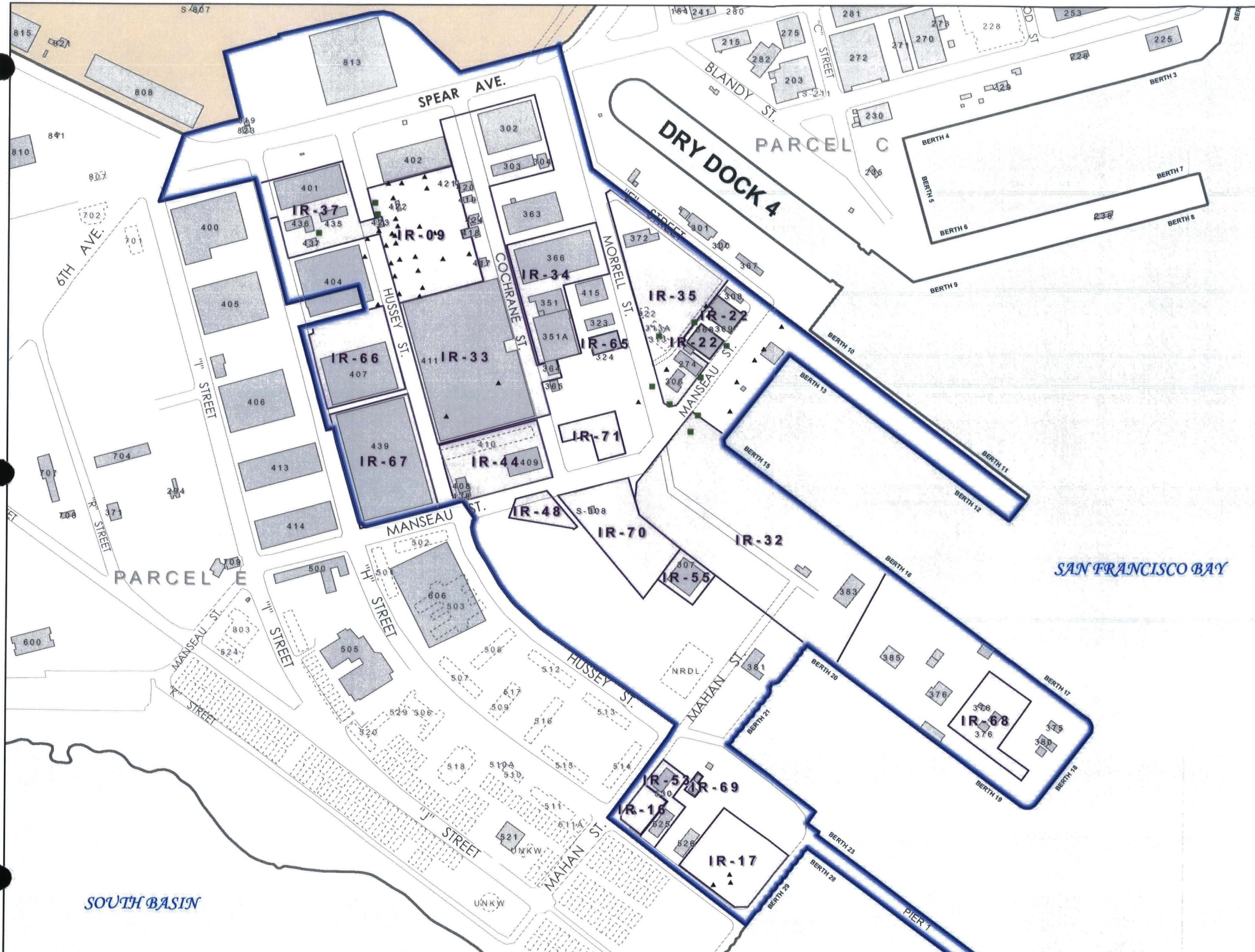
U.S. Department of the Navy, BRAC PMO West, San Diego, California

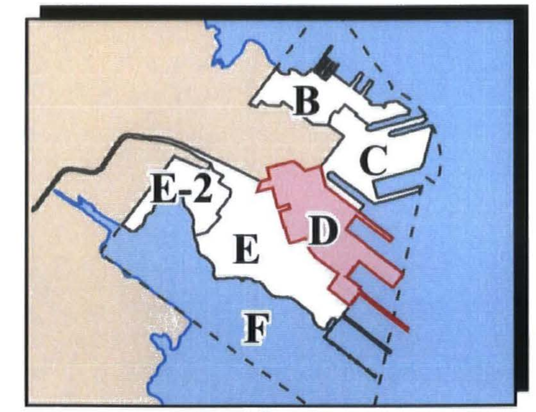
FIGURE 2-19

CHROMIUM VI DISTRIBUTION IN SOIL 0 TO 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Chromium VI in soil_0-10ft.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: >10 feet bgs

- Detected Results
- Nondetected Results
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

>	Greater than
bgs	Below ground surface
IR	Installation Restoration
mg/kg	Milligrams per kilogram
PRG	Preliminary remediation goal

N

350 0 350

Scale in Feet

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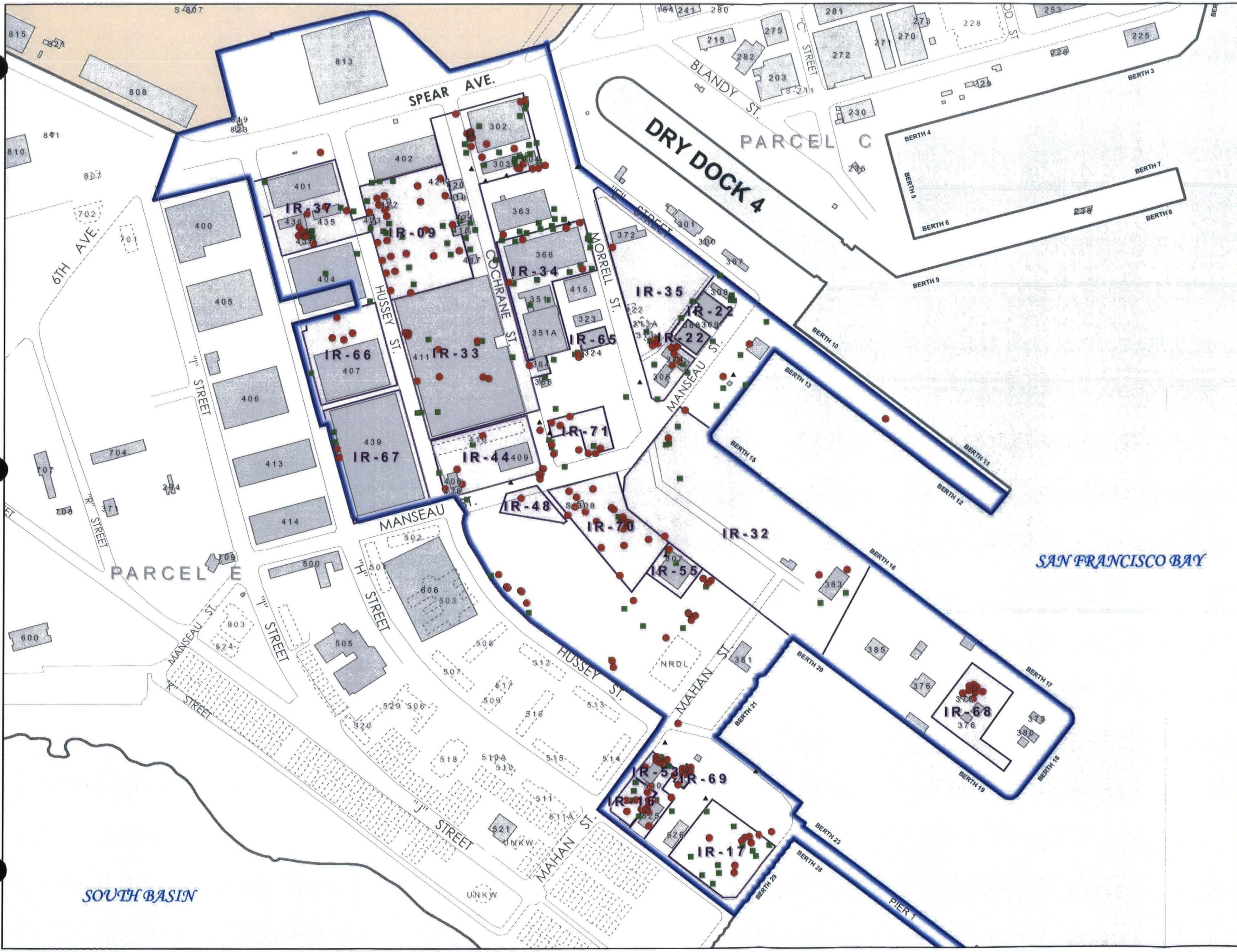
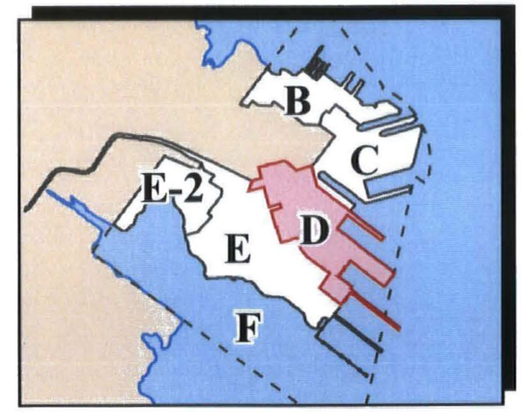
FIGURE 2-20

CHROMIUM VI DISTRIBUTION IN SOIL GREATER THAN 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Chromium VI in soil_gt10ft.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: 0-10 feet bgs

- Location Exceeds HPAL Comparison Criteria
- Location Does Not Exceed HPAL Comparison Criteria
- Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

HPAL for lead is 8.99 mg/kg

bgs Below ground surface
HPAL Hunters Point ambient level
IR Installation Restoration
mg/kg Milligrams per kilogram

350 0 350
Scale in Feet

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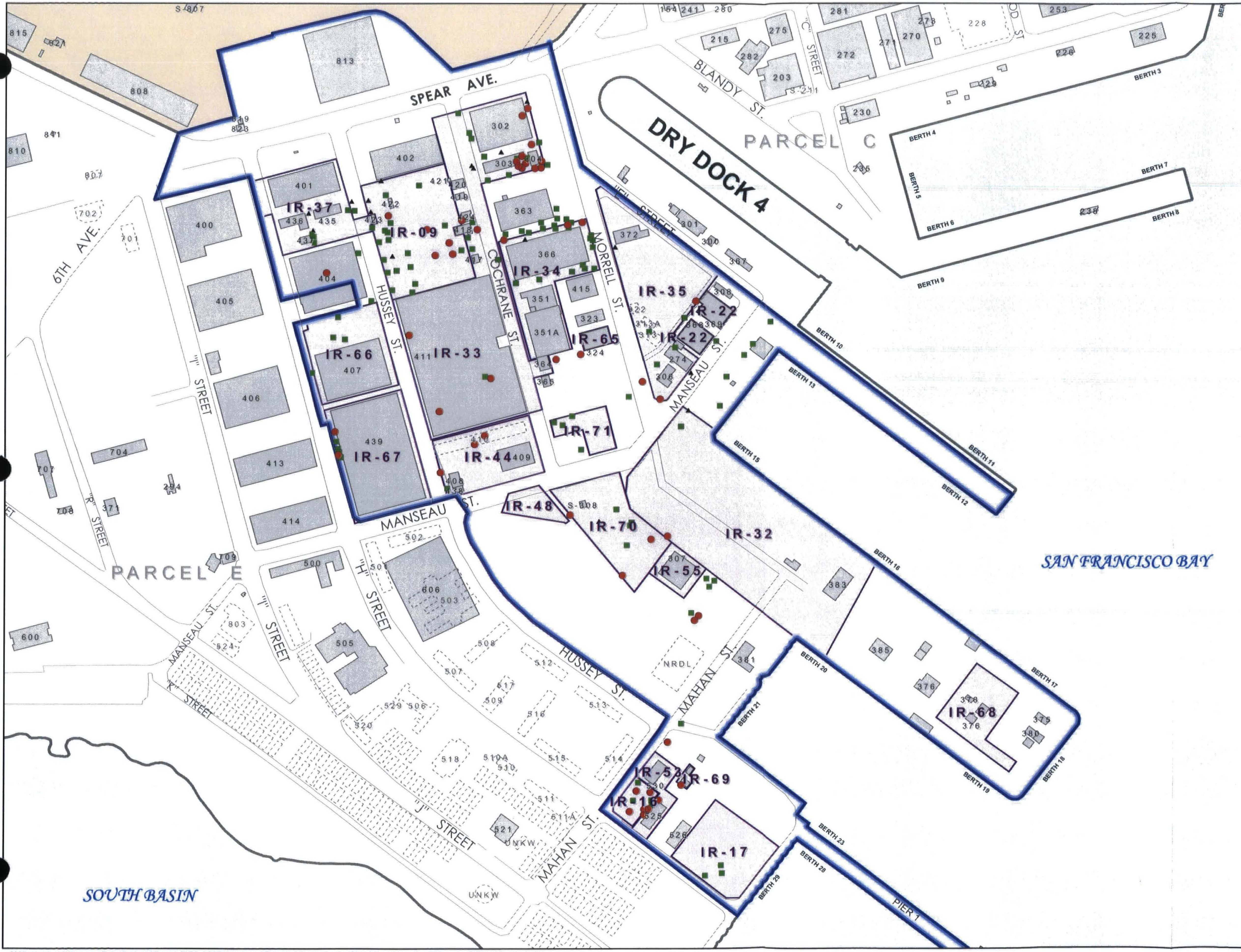
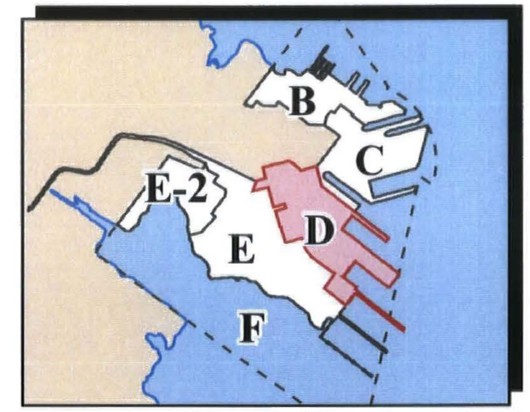
FIGURE 2-21

LEAD DISTRIBUTION IN SOIL 0 TO 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Lead in soil_0-10ft.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: >10 feet bgs

- Location Exceeds HPAL Comparison Criteria
- Location Does Not Exceed HPAL Comparison Criteria
- Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

HPAL for lead is 8.99 mg/kg

>	Greater than
bgs	Below ground surface
HPAL	Hunters Point ambient level
IR	Installation Restoration
mg/kg	Milligrams per kilogram

N

350 0 350

Scale in Feet

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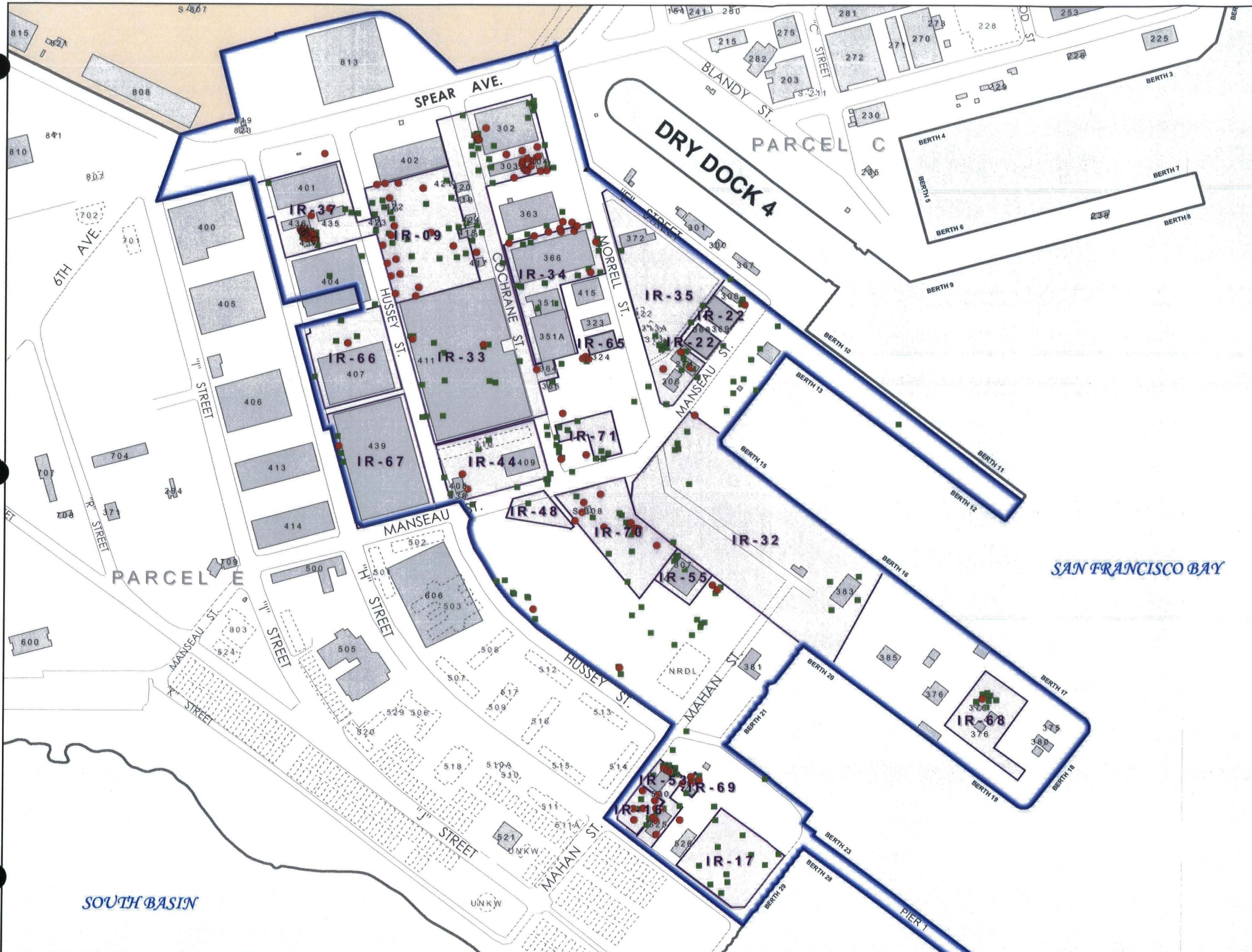
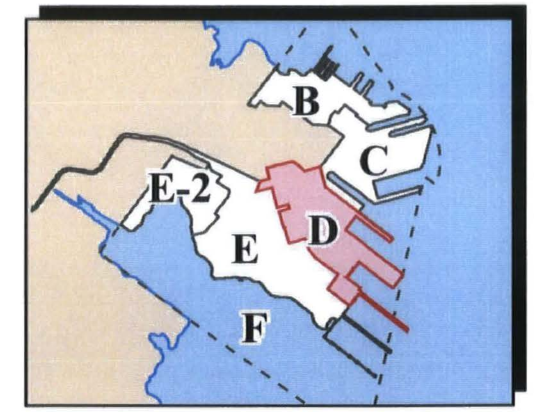
FIGURE 2-22

LEAD DISTRIBUTION IN SOIL GREATER THAN 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Lead in soil_gt10ft.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: 0-10 feet bgs

- Location Exceeds HPAL Comparison Criteria
- Location Does Not Exceed HPAL Comparison Criteria
- Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

HPAL for manganese is 1,431 mg/kg

bgs Below ground surface
HPAL Hunters Point ambient level
IR Installation Restoration
mg/kg Milligrams per kilogram

350 0 350

Scale in Feet

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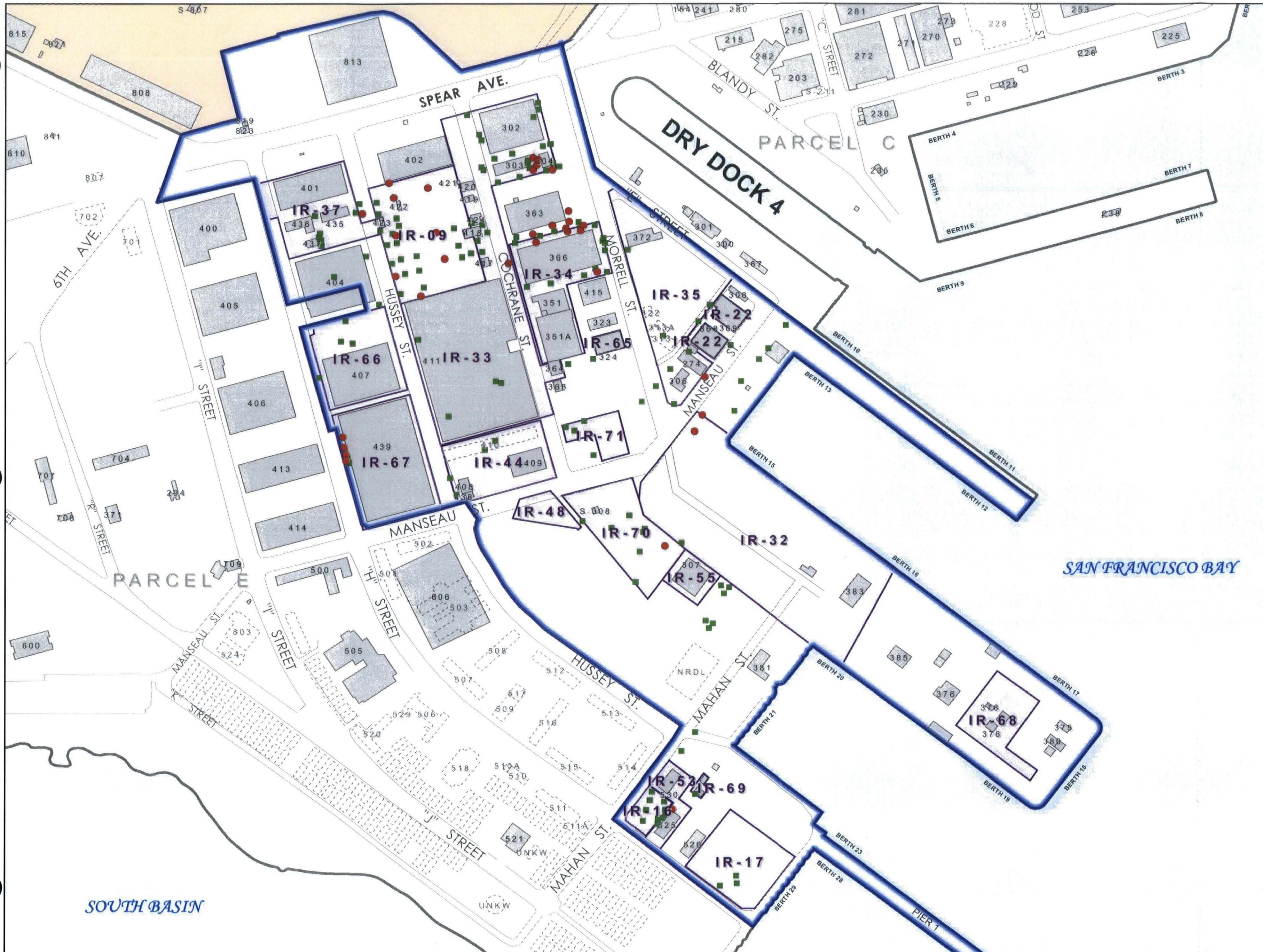
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-23

MANGANESE DISTRIBUTION IN SOIL 0 TO 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Manganese in soil_0-10ft.mxd TtEMI-SF Kevin Ernst



Soil Results: >10 feet bgs

- Location Exceeds HPAL Comparison Criteria
- Location Does Not Exceed HPAL Comparison Criteria
- Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

HPAL for manganese is 1,431 mg/kg

>	Greater than
bgs	Below ground surface
HPAL	Hunters Point ambient level
IR	Installation Restoration
mg/kg	Milligrams per kilogram

350 0 350

Scale in Feet

SulTech

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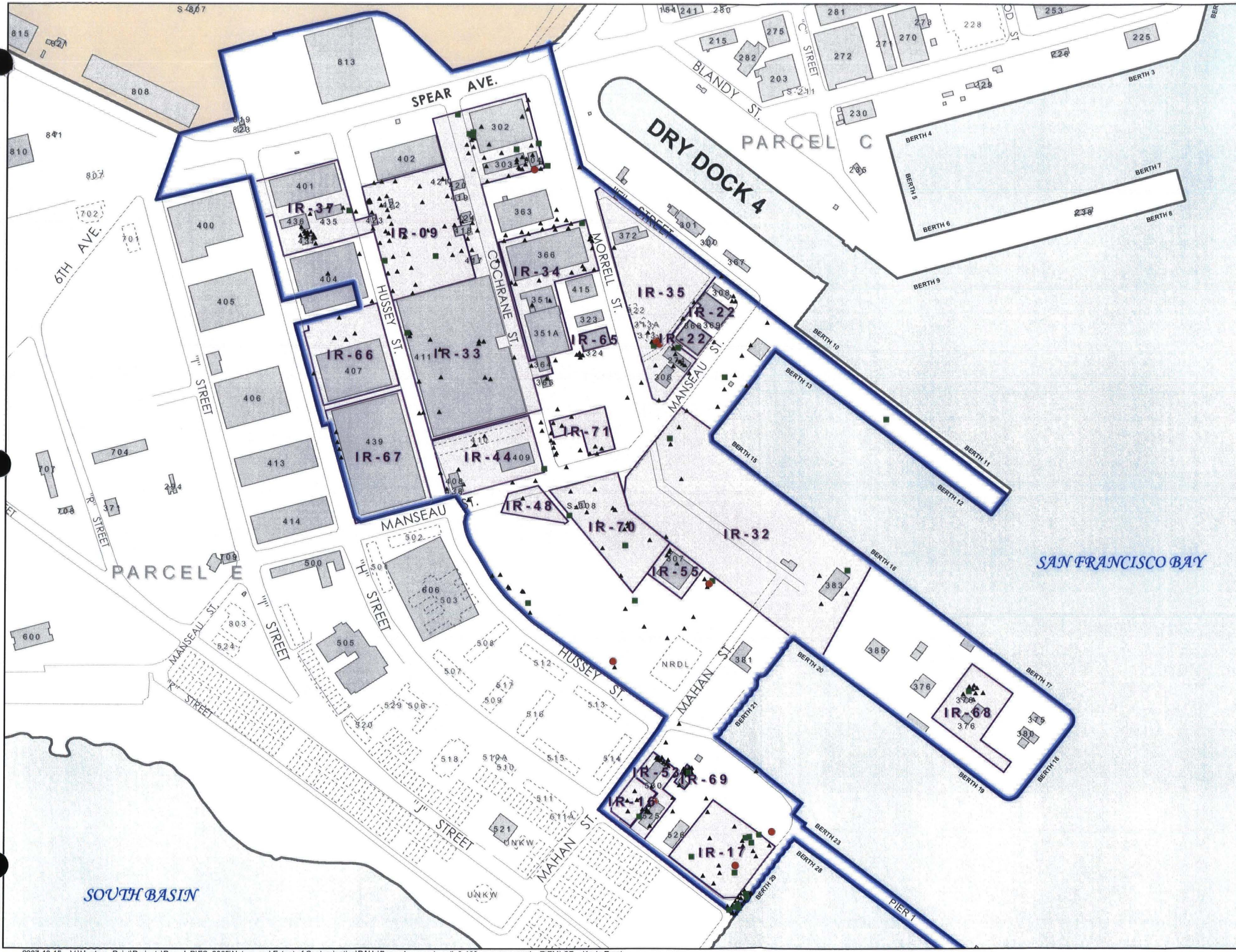
FIGURE 2-24

MANGANESE DISTRIBUTION IN SOIL GREATER THAN 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Metals\Manganese in soil_gt10ft.mxd TtEMI-SF Kevin Ernst



Location Map

Soil Results: 0-10 feet bgs

- Result Greater than 0.33 ppm
- Result Less than or Equal to 0.33 ppm
- Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

0.33 ppm is the lowest laboratory reporting limit for PAHs

bgs Below ground surface
IR Installation Restoration
PAH Polyaromatic hydrocarbon
ppm Part per million

350 0 350
Scale in Feet

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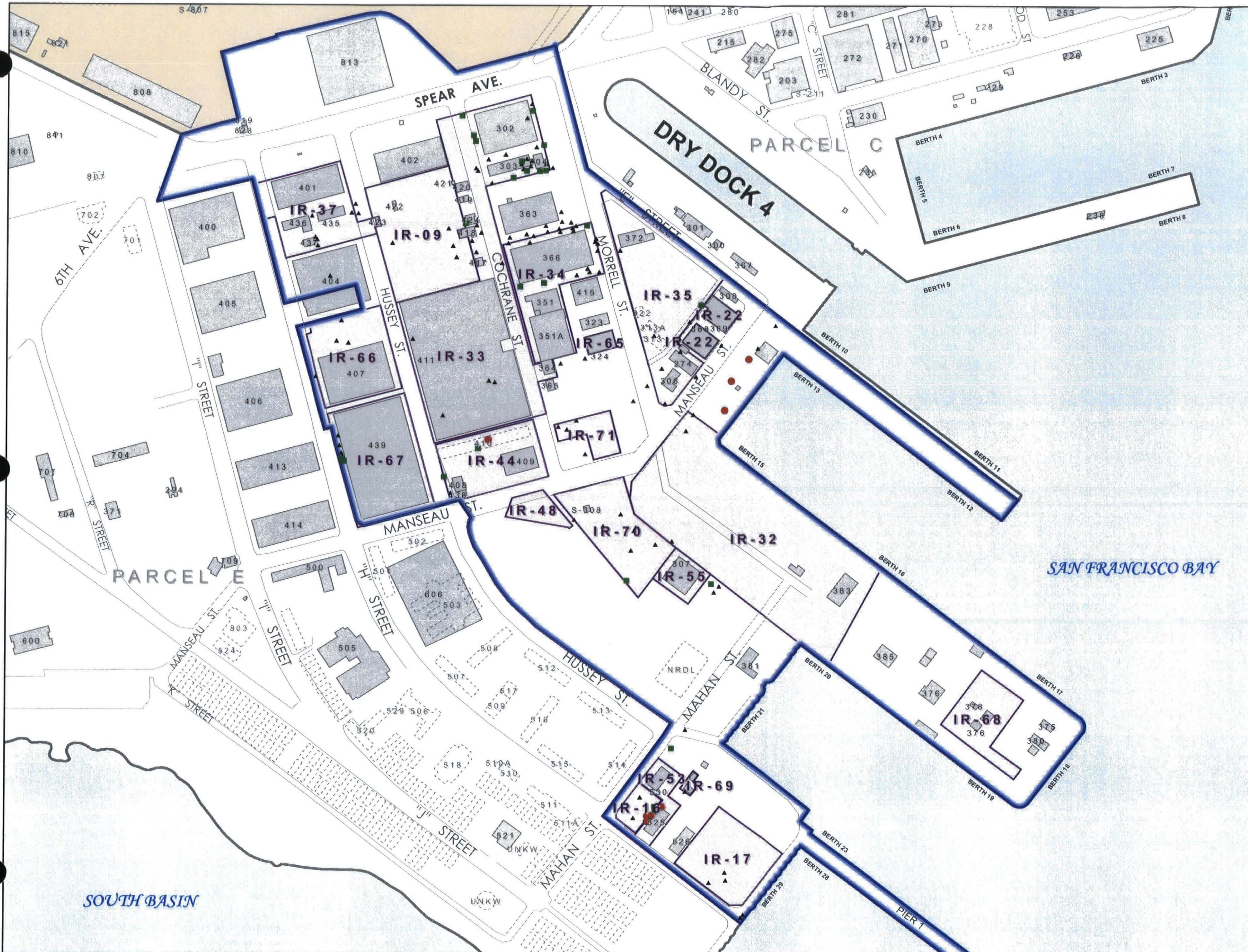
U.S. Department of the Navy, BRAC PMO West, San Diego, California

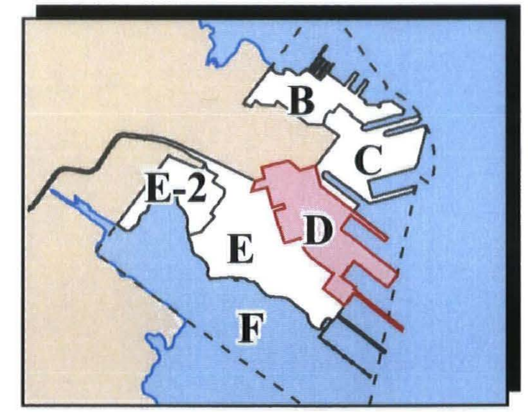
FIGURE 2-25

BENZO(A)PYRENE DISTRIBUTION IN SOIL 0 TO 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\PAHs\BenzoApyrene in soil_0-10ft_summary.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: >10 feet bgs

- Result Greater than 0.33 ppm
- Result Less than or Equal to 0.33 ppm
- Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

0.33 ppm is the lowest laboratory reporting limit for PAHs

>	Greater than
bgs	Below ground surface
IR	Installation Restoration
PAH	Polyaromatic hydrocarbon
ppm	Part per million

350 0 350
Scale in Feet

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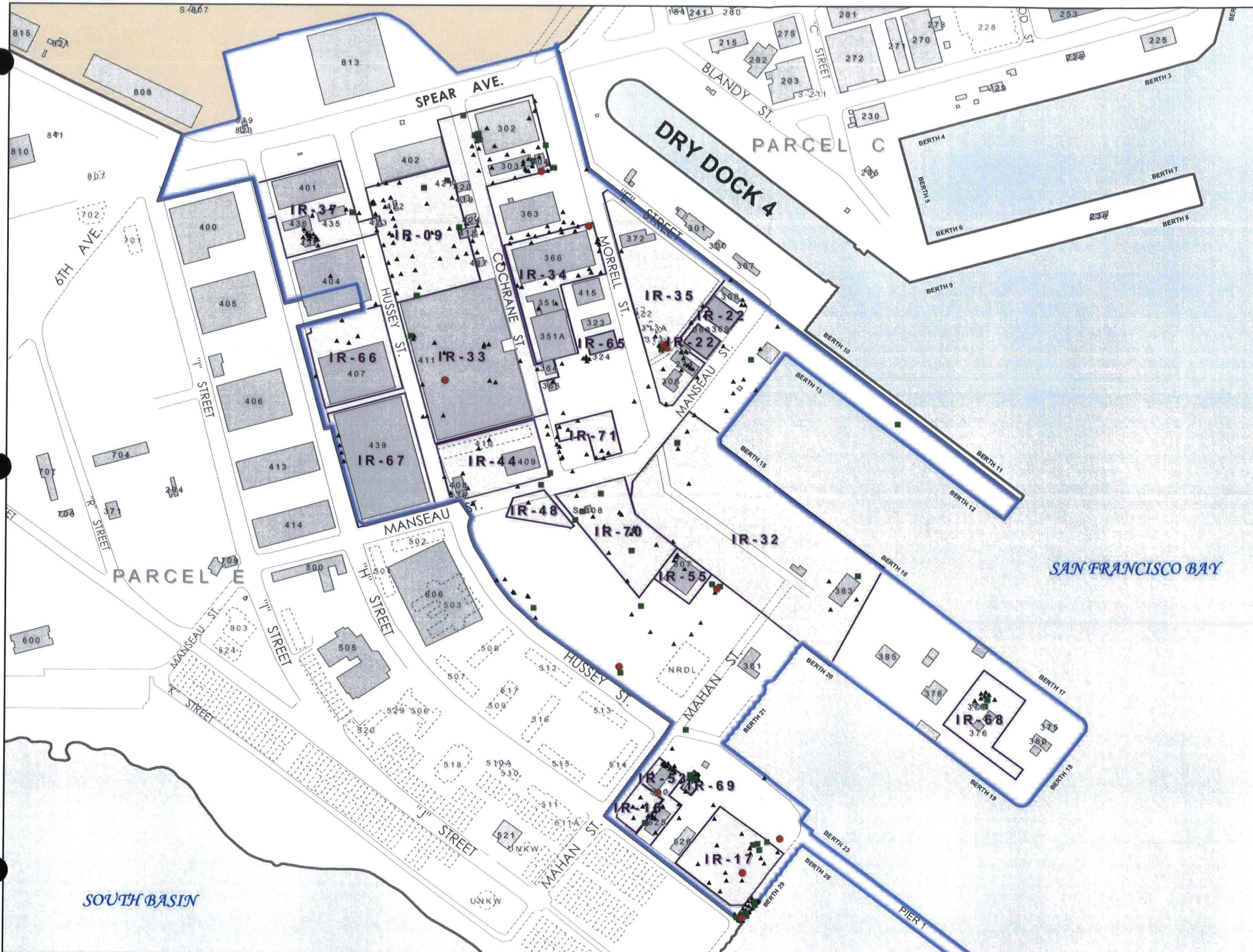
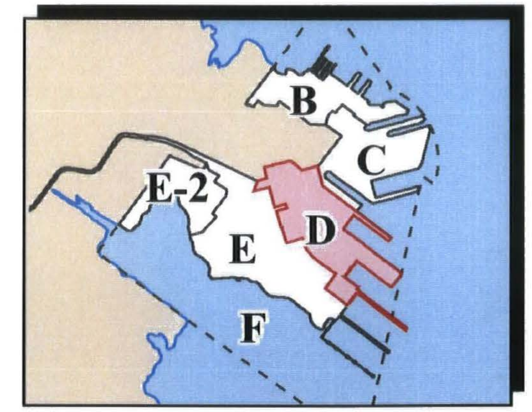
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-26
BENZO(A)PYRENE DISTRIBUTION IN SOIL GREATER THAN 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\PAHs\BenzoApyrene in soil_gt10ft_summary.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: 0-10 ft bgs

- Results Greather than 0.33 ppm
- Results Less than or Equal to 0.33 ppm
- Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

0.33 ppm is the lowest laboratory reporting limit for PAHs

bgs Below ground surface
IR Installation Restoration
PAH Polyaromatic hydrocarbon
ppm Part per million

350 0 350
Scale in Feet

SulTech

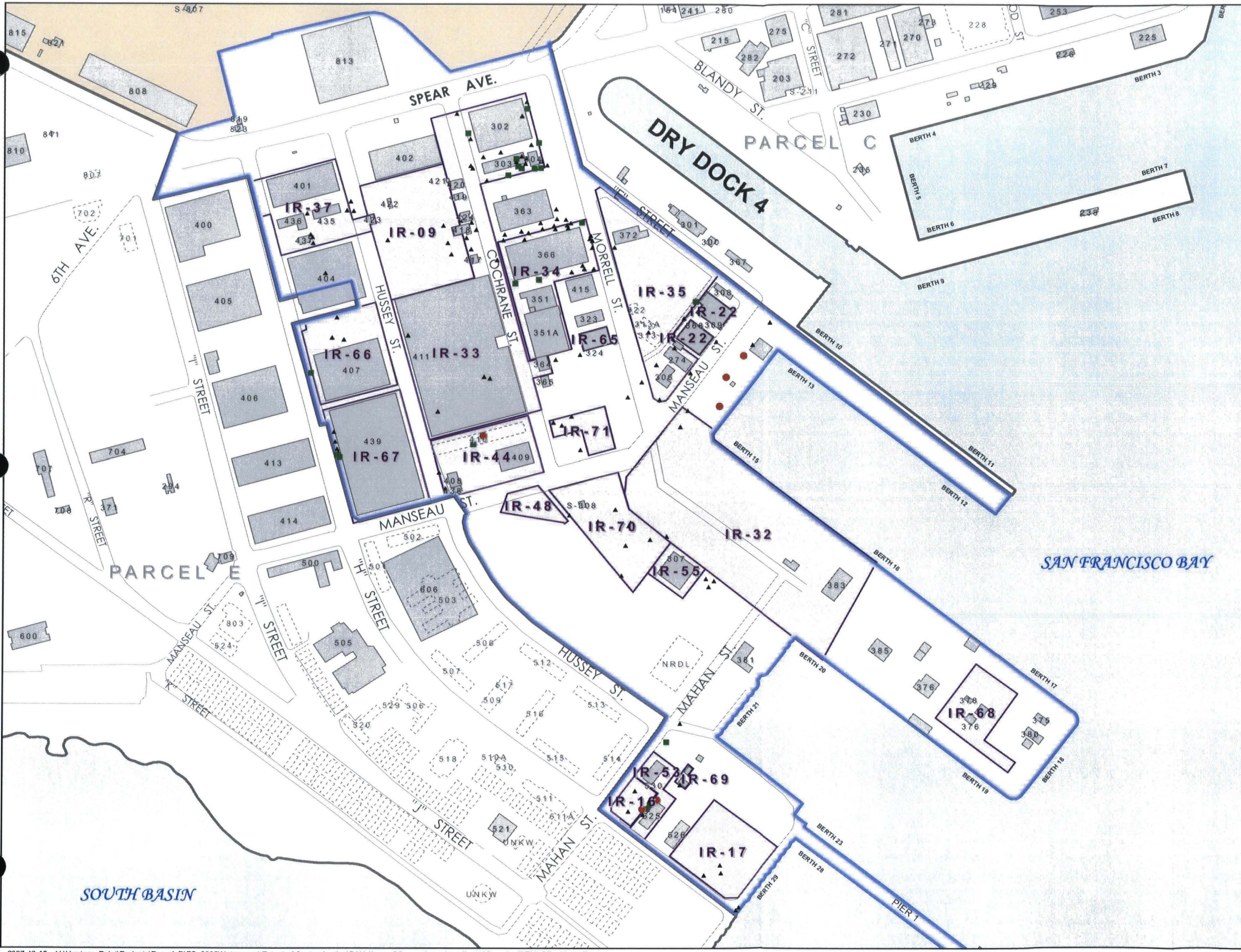
Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

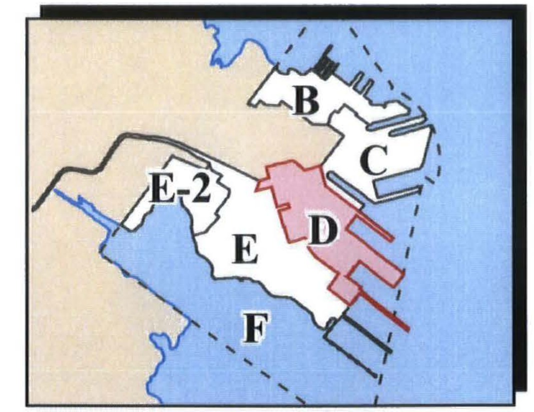
FIGURE 2-27

BENZO(B)FLUORANTHENE DISTRIBUTION IN SOIL 0 TO 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\PAHs\benzoBfluroanthene in soil_0-10ft.mxd TtEMI-SF Kevin Ernst





Location Map

Soil Results: >10 feet bgs

- ● Result Greater than 0.33 ppm
- ■ Result Less than or Equal to 0.33 ppm
- ▲ Nondetected Result
- Parcel D Boundary
- Other Parcel Boundaries
- IR Site Boundary
- Non-Navy Property
- Existing Building
- Demolished Building
- Road

Notes:

0.33 ppm is the lowest laboratory reporting limit for PAHs

bgs	Below ground surface
IR	Installation Restoration
PAH	Polyaromatic hydrocarbon
ppm	Part per million

N

350 0 350

Scale in Feet

SulTech

Hunters Point Shipyard, San Francisco, California

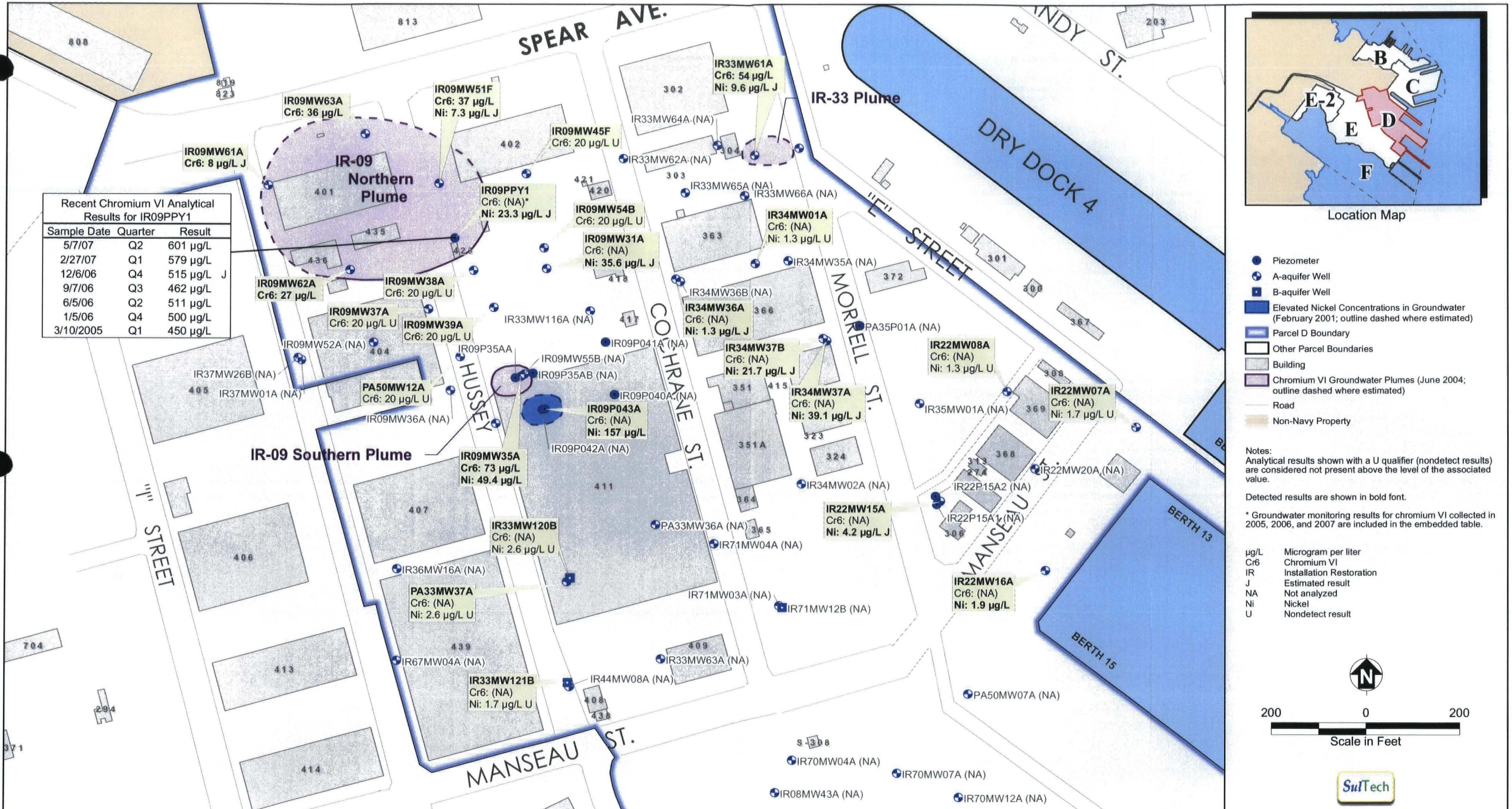
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-28

BENZO(B)FLUORANTHENE DISTRIBUTION IN SOIL GREATER THAN 10 FEET BELOW GROUND SURFACE

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\PAHs\benzoBfluroanthene in soil_gt10ft.mxd TtEMI-SF Kevin Ernst



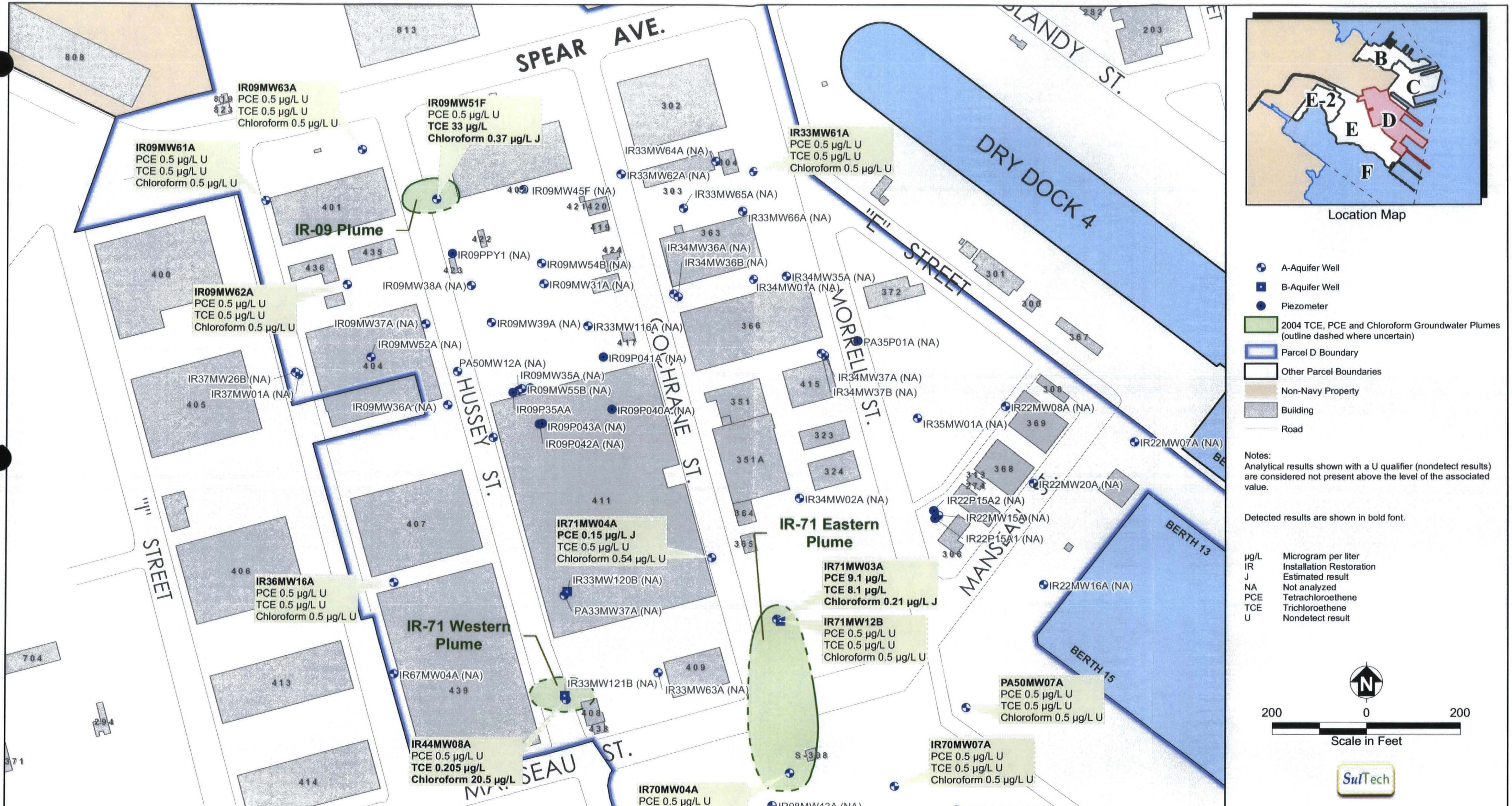
Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-29

CHROMIUM VI AND NICKEL CONCENTRATIONS IN THE A-AQUIFER

Revised Feasibility Study Report for Parcel D

2007-11-29 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Groundwater\Parcel_CRVI_gw_plumes_11x17.mxd TtEMI-SF Kevin Ernst



Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2-30
PCE, TCE, AND CHLOROFORM CONCENTRATIONS IN THE A-AQUIFER

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Groundwater\Parcel_D_PCE_TCE_CHL4M_gw_plumes_11x17.mxd TtEMI-SF Kevin Ernst

TABLES

TABLE 2-1: PARCEL D HISTORICAL AND CURRENT USE OF BUILDINGS
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Site	Building No.[a]	Area (ft^2)[b]	Former Shipyard Use (1940 to 1974)[c]	Post-Navy Use[d]	Radiological Contamination Potential[e]
IR-22	368	8,000	Navy service building used by the former tenant as a woodworking operation and a pipefitting shop	Woodworking	None
	369	8,810	Navy storage of public works equipment; rigging shop	Vacant	None
IR-32	370	1,209	Latrine, restrooms, and showers	Vacant	None
	383	10,200	Poseidon, shipping, and receiving. Vicinity was a turn-in area for radium devices before building was constructed.	Vacant	Unlikely
IR-33 North	302/303	44,775	Transportation shop for automotive and locomotive repairs	Storage	None
	304	1,070	Service station	Vacant	None
IR-33 South	364	2,255	Storage for the NRDL radiological research and chemistry operations	Laboratory for refining metals (Young Laboratory)	Known-Restricted Access to Room 107
	365	842	Storage, offices, and film developing laboratory	Vacant	Unlikely
	411	287,976	Ship-fitters shops and boiler maker shop	Workshop and storage	Unlikely
	417	500	Acetylene manifolds and welding engineers	Storage	None
	418	1,387	Quality and reliability assurance welding engineering facility, and metal spraying	Offices and workshop	None
	424	805	Area Time House No. 4/Oxygen cylinder charging facility	Storage	None
IR-34	351	38,204	Electronics shop, electronics and optical laboratory, sampling laboratory, biological research laboratories, machine shop, offices, storeroom.	Vacant	Likely

TABLE 2-1: PARCEL D HISTORICAL AND CURRENT USE OF BUILDINGS (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Site	Building No.[a]	Area (ft^2)[b]	Former Shipyard Use (1940 to 1974)[c]	Post-Navy Use[d]	Radiological Contamination Potential[e]
34	351A	22,879	NRDL offices, instrument repair, metrology laboratory, guard post.	Vacant	Likely
	366	36,313	Boat and plastic shop (former 351B). NRDL instrument calibration; chemical laboratory	Workshop	Known-Continued Access
IR-35	274	4,000	Midway Liaison Office	Vacant	Unlikely
	306	1,752	Electrical Substation I	Electrical Substation	None
	313	Demolished	NRDL Instrumentation laboratory, stockroom and storage	Demolished, vacant area (site of former buildings)	Likely
	313A	Demolished	Laboratory offices, training and storage	Demolished, vacant area (site of former buildings)	Likely
	372	2,875	Prefab decking shelter	Storage	None
	313(d) and 313A(d)	Demolished	NRDL Annex G	Demolished	None
IR-37	401	44,064	Public works shop	Art activities workshop and storage	None
	423	392	Compressor hut and paint storage	Vacant	None
	435	3,000	Equipment storage	Storage	None
	436	3,000	Painting and paint storage facility	Storage	None
	437	984	Pipe storage	Vacant	None
IR-44	408	1,836	Furnace/smelter	Vacant	Likely
	409	230	Welder motor generator	Vacant	None
	410	230	Welder motor generator	Vacant	None
	438	432	Metal spray shelter	Vacant	None

TABLE 2-1: PARCEL D HISTORICAL AND CURRENT USE OF BUILDINGS (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Site	Building No.[a]	Area (ft^2)[b]	Former Shipyard Use (1940 to 1974)[c]	Post-Navy Use[d]	Radiological Contamination Potential[e]
IR-53	525	4,000	Storehouse for containers of adhesive, joint sealing compounds, paint emulsions, and other materials	Vacant	None
	530	3,200	Public works shop used as an automotive hobby shop	Vacant	None
IR-55	307	10,000	Electronic assembly facility	Vacant	None
IR-65	324	6,000	Carbon dioxide refilling station	Vacant	None
IR-66	407	42,183	Ships operational activity parts and offices	Moving and storage	None
IR-67	439	100,000	Sheet metal shop/warehouse	Vacant	None
IR-68	374(d)	Demolished	Poseidon control and instrumentation hut	Demolished, vacant area (site of former buildings)	None
	375(d)	Demolished	Poseidon control hut	Demolished, vacant area (site of former buildings)	None
	376	480	Poseidon control hut	Vacant	None
	378	800	Latrine, restroom, and shower	Vacant	None
	379	1,280	Poseidon engineering	Office	None
	382	1,140	Poseidon arresting system shelter	Vacant	None
IR-69	523	574	Saltwater pump house	Vacant	None
IR-70	S-308	18,000	Storage	Storage	None
NA	305	Unknown	Unknown	Storage	None
NA	308/308A	1,463	Salt water pump house	Salt water pump house	None
NA	311	1,800	Latrine and ships office	Unknown	None
NA	317	Demolished	Temporary animal quarters for NRDL	Demolished, vacant area (site of former buildings)	Likely
NA	322	Demolished	NRDL office, NRDL Instruments Branch and Field Office	Demolished, vacant area (site of former buildings)	Likely

TABLE 2-1: PARCEL D HISTORICAL AND CURRENT USE OF BUILDINGS (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Site	Building No.[a]	Area (ft^2)[b]	Former Shipyard Use (1940 to 1974)[c]	Post-Navy Use[d]	Radiological Contamination Potential[e]
NA	323	4,000	Shore activities, electronics, and boat shop	Art activities	None
NA	363	21,471	Woodworking shop	Workshop (Quality Craftsman)	None
NA	373(d)	Unknown	Poseidon control hut No.1 and 5	Demolished, vacant area	None
NA	377	4,240	Poseidon systems test engineering	Vacant	None
NA	380	2,084	Poseidon test machine	Vacant	None
NA	381	4,000	West coast shock testing facility	Vacant	None
NA	384	4,664	Poseidon engineering	Fire department equipment and storage	None
NA	385	3,672	Poseidon	Storage	None
NA	402	36,314	Supply storehouse, and Q and RA offices	Moving and storage	None
NA	404	50,859	Supply storehouse	Workshop/manufacturing sheet metal products	None
NA	412	82	Railroad scales	Railroad scales	None
NA	419	682	Oxygen converter	Storage, Public Works Center	None
NA	710	88	Latrine	Vacant	None
NA	813	68,644	General warehouse and offices, supply storehouse	Vacant	Unlikely
NA	819	120	Sewer pump station A	Sewer pump station	Likely
NA	Former NRDL Site	2,400	Unknown, potential storage site of radiological material	Open area	Likely
NA	Gun Mole Pier		Decontamination and laboratory facility	Unused	Likely

TABLE 2-1: PARCEL D HISTORICAL AND CURRENT USE OF BUILDINGS (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Notes:

a	List of buildings is based on the basewide environmental baseline survey for Hunters Point Shipyard (Tetra Tech 1998).
b	Area from the basewide environmental baseline survey for Hunters Point Shipyard (Tetra Tech 1998).
c	HPS was deactivated as a Navy facility in 1974.
d	Post-Navy use reflects usage in the basewide environmental baseline survey for Hunters Point Shipyard (Tetra Tech 1998).
e	Radiologically affected areas and the contamination potential are presented in the Historical Radiological Assessment (Navy 2004b). A radiologically impacted area is defined as: An area that has or historically had a potential for general radioactive materials contamination based on the site operating history or known contamination detected during previous radiation surveys. Impacted sites include sites where radioactive materials were used or stored; sites where known spills, discharges, or other instances involving radioactive materials have occurred; or sites where radioactive materials might have been disposed of or buried.
ft^2	Square feet
IR	Installation Restoration
NA	Building not located within IR site boundary
Navy	U.S. Department of the Navy
NRDL	Naval Radiological Defense Laboratory
Tetra Tech	Tetra Tech EM Inc.

References:

Navy. 2004b. "Historical Radiological Assessment, Volume II, Use of General Radioactive Materials, 1939-2003, Hunters Point Shipyard, San Francisco, California." August 31.

Tetra Tech. 1998. "Hunters Point Shipyard Basewide Environmental Baseline Survey." September 4.

TABLE 2-2: SITE GEOLOGIC AND HYDROGEOLOGIC UNITS AT PARCEL D
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site[a]	Geologic Unit[b]	Thickness (feet)	Description	Hydrogeologic Unit	Depth to Groundwater (feet bgs)
IR-09	Artificial Fill (Qaf)	10 to 30	Silty sand with gravel and clayey gravel	A-aquifer	8 to 10
	Bay Mud Deposits (Qbm)	0 to 15	Fine-grained clay, silt, and sandy clay with trace shell fragments; this unit is present only at the southern portion of the site	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	0 to 35	Poorly graded sand and silty sand with clay	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	Not determined
IR-16	Artificial Fill (Qaf)	25 to 30	Interbedded sandy and silty gravel, and gravelly clay	A-aquifer	7 to 9
	Bay Mud Deposits (Qbm)	23 to 30	Clay with shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	10 to 20	Poorly graded sand with some shell fragments	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-17	Artificial Fill (Qaf)	0 to 2	Silty sand and gravel	A-aquifer	7 to 8
	Undifferentiated Upper Sand Deposits (Quus)	25 to 30	Poorly graded and well-graded sand	A-aquifer	7 to 8
	Bay Mud Deposits (Qbm)	30 to 45	Clay with up to 30 percent shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	Unknown	Presence not verified; no borehole penetrations through the Bay Mud	B-aquifer	NA
	Franciscan Complex Bedrock (KJf)	NA	Serpentine based on borings in adjacent sites	Bedrock water-bearing zone	No monitoring wells installed
IR-22	Artificial Fill (Qaf)	15 to 30	Sand and gravel, and clayey gravel	A-aquifer	8 to 10
	Undifferentiated Upper Sand Deposits (Quus)	0 to 15	Poorly graded sand, and silty and clayey sand with shell fragments	A-aquifer	NA

TABLE 2-2: SITE GEOLOGIC AND HYDROGEOLOGIC UNITS AT PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site[a]	Geologic Unit[b]	Thickness (feet)	Description	Hydrogeologic Unit	Depth to Groundwater (feet bgs)
IR-22 (cont.)	Bay Mud Deposits (Qbm)	0 to 15	Sandy clay; this unit is absent in the northern and western portions of the site	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	0 to 35	Clayey sand and sandy clay with gravel	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine and shale matrix mélange; shale matrix mélange includes blocks of greenstone	Bedrock water-bearing zone	No monitoring wells installed
IR-32	Artificial Fill (Qaf)	30 to 60	Clayey gravel with sand and poorly graded medium sand	A-aquifer	7 to 9
	Bay Mud Deposits (Qbm)	10 to 60	Clay with shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	85 to 100	Poorly graded sand with minor shell fragments	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-33 North	Artificial Fill (Qaf)	10 to 25	Sand and gravel, and clayey gravel	A-aquifer	7 to 8
	Bay Mud Deposits (Qbm)	0 to 5	Clay with shell fragments; this unit is absent in the eastern portion of the site	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	0 to 20	Fine gray sand and brown clay	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Shale matrix mélange	Bedrock water-bearing zone	No monitoring wells installed
IR-33 South	Artificial Fill (Qaf)	10 to 25	Clayey gravel	A-aquifer	2 to 8
	Bay Mud Deposits (Qbm)	5 to 25	Clay with shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	0 to 35	Fine sand and clay	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Predominantly serpentine	Bedrock water-bearing zone	No monitoring wells installed

TABLE 2-2: SITE GEOLOGIC AND HYDROGEOLOGIC UNITS AT PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site[a]	Geologic Unit[b]	Thickness (feet)	Description	Hydrogeologic Unit	Depth to Groundwater (feet bgs)
IR-34	Artificial Fill (Qaf)	15 to 30	Coarse-grained clayey and silty gravel with localized lenses of clay	A-aquifer	8 to 9
	Undifferentiated Upper Sand Deposits (Quus)	0 to 7	Poorly graded sand with shell fragments	A-aquifer	9
	Bay Mud Deposits (Qbm)	0 to 9.5	Clay with shell fragments; locally absent at Well IR34B030	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	0 to 57	Silty sand	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Shale matrix mélange	Bedrock water-bearing zone	No monitoring wells installed
IR-35	Artificial Fill (Qaf)	25 to 35	Bedrock-derived clayey gravel, and sand and gravel	A-aquifer	9 to 12
	Undifferentiated Upper Sand Deposits (Quus)	0 to 2	Clayey sand with shell fragments	A-aquifer	9 to 12
	Bay Mud Deposits (Qbm)	0 to 10	Clay with shell fragments; this unit is present only in the eastern corner of the site	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	0 to 42	Clay and sandy clay with rock fragments	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Predominantly serpentine in northeastern portion; shale matrix mélange in southwestern portion	Bedrock water-bearing zone	No monitoring wells installed
IR-37	Artificial Fill (Qaf)	5 to 20	Serpentine gravel and sand	A-aquifer	6 to 9
	Franciscan Complex Bedrock (KJf)	NA	Serpentine; this unit directly underlies the A-aquifer and is likely hydraulically connected	Bedrock water-bearing zone	8 to 10
IR-44	Artificial Fill (Qaf)	10 to 15	Sand and gravel, and clayey silt with shell fragments	A-aquifer	6
	Bay Mud Deposits (Qbm)	25 to 45	Clay with up to 35 percent shell fragments	Aquitard	NA

TABLE 2-2: SITE GEOLOGIC AND HYDROGEOLOGIC UNITS AT PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site[a]	Geologic Unit[b]	Thickness (feet)	Description	Hydrogeologic Unit	Depth to Groundwater (feet bgs)
IR-44 (cont.)	Undifferentiated Sedimentary Deposits (Qu)	0 to 50	Interbedded sand and clay with rock fragments and decayed vegetation	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Predominantly serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-48	Artificial Fill (Qaf)	10 to 25	Sandy gravel and gravelly clay	A-aquifer	9 to 10
	Bay Mud Deposits (Qbm)	20 to 45	Clay with up to 35 percent shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	20 to 50	Interbedded sand and clay with rock fragments	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-53	Artificial Fill (Qaf)	25 to 30	Clayey gravel and poorly graded sand	A-aquifer	7 to 9
	Undifferentiated Upper Sand Deposits (Quus)	0 to 11	Poorly graded sand with shell fragments	A-aquifer	7 to 9
	Bay Mud Deposits (Qbm)	25 to 35	Sandy clay and clay with up to 40 percent shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	Unknown	Not verified; no borings penetrated through the Bay Mud Deposits	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-55	Artificial Fill (Qaf)	20 to 30	Sand and gravel with localized lenses of bedrock-derived coarse gravel and boulder fill	A-aquifer	5
	Undifferentiated Upper Sand Deposits (Quus)	20 to 30	Poorly graded sand with trace shell fragments	A-aquifer	5
	Bay Mud Deposits (Qbm)	30 to 45	Sandy clay with up to 20 percent shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	50 to 78	Interbedded clay and sandy clay with decayed vegetation	B-aquifer	No monitoring wells installed

TABLE 2-2: SITE GEOLOGIC AND HYDROGEOLOGIC UNITS AT PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site[a]	Geologic Unit[b]	Thickness (feet)	Description	Hydrogeologic Unit	Depth to Groundwater (feet bgs)
IR-55 (cont.)	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-65	Artificial Fill (Qaf)	10 to 30	Sandy clay and clayey gravel	A-aquifer	9
	Bay Mud Deposits (Qbm)	0 to 10	Clay and sandy clay with up to 25 percent shell fragments; absent in easternmost portion of site	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	50 to 60	Firm sand and clay with rock fragments and decayed vegetation	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine and shale matrix mélange	Bedrock water-bearing zone	No monitoring wells installed
IR-66	Artificial Fill (Qaf)	10 to 25	Sand and gravel, and gravelly clay	A-aquifer	8 to 9
	Bay Mud Deposits (Qbm)	8 to 25	Clay with 5 to 50 percent shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	0 to 15	Fine sand and clay with rock fragments	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-67	Artificial Fill (Qaf)	10 to 25	Sand and gravel with some clay	A-aquifer	7 to 9
	Bay Mud Deposits (Qbm)	19 to 35	Clay with shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	15 to 55	Sandy clay with gravel that grades to firm clay with depth	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-68	Artificial Fill (Qaf)	10 to 30	Sand and gravel, and sandy clay with gravel	A-aquifer	6 to 9 (est)
	Undifferentiated Upper Sand Deposits (Quus)	8 to 22	Poorly graded sand with 5 to 10 percent shell fragments	A-aquifer	6 to 9 (est)
	Bay Mud Deposits (Qbm)	45 to 90	Clay with shell fragments	Aquitard	NA

TABLE 2-2: SITE GEOLOGIC AND HYDROGEOLOGIC UNITS AT PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site[a]	Geologic Unit[b]	Thickness (feet)	Description	Hydrogeologic Unit	Depth to Groundwater (feet bgs)
IR-68 (cont.)	Undifferentiated Sedimentary Deposits (Qu)	100 to 150	Interbedded fine sand and sandy clay that grades to clay with rock fragments at depth	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine and shale matrix mélange	Bedrock water-bearing zone	No monitoring wells installed
IR-69	Artificial Fill (Qaf)	25 to 30	Clay with gravel and sandy clay	A-aquifer	7 to 9
	Undifferentiated Upper Sand Deposits (Quus)	10.5 to 24	Poorly graded sand with up to 20 percent shell fragments	A-aquifer	7 to 9
	Bay Mud Deposits (Qbm)	24 to 30	Clay and sandy clay with shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	15 to 25	Sandy clay with abundant rock fragments	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-70	Artificial Fill (Qaf)	20 to 30	Sandy gravel and gravelly clay with lenses of bedrock-derived cobble and boulder fill	A-aquifer	6 to 12
	Bay Mud Deposits (Qbm)	7 to 50	Clay with up to 50 percent rock fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	20 to 50	Interbedded clay with shell fragments, clayey silt, and sandy clay	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine	Bedrock water-bearing zone	No monitoring wells installed
IR-71	Artificial Fill (Qaf)	25 to 40	Sandy clay and gravel	A-aquifer	8 to 9
	Bay Mud Deposits (Qbm)	8 to 27	Clay with up to 50 percent shell fragments	Aquitard	NA
	Undifferentiated Sedimentary Deposits (Qu)	45 to 55	Interbedded sand and clay with decayed vegetation and rock fragments	B-aquifer	No monitoring wells installed
	Franciscan Complex Bedrock (KJf)	NA	Serpentine and shale matrix mélange	Bedrock water-bearing zone	No monitoring wells installed

TABLE 2-2: SITE GEOLOGIC AND HYDROGEOLOGIC UNITS AT PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Notes:

a	Utility sites (IR-45, IR-50, and IR-51) are addressed within other sites.
b	The geologic and hydrogeologic units listed for each IR site area from top (the youngest) to bottom (the oldest).
bgs	Below ground surface
IR	Installation Restoration
NA	Not applicable

TABLE 2-3: SUMMARY OF SITE-SPECIFIC FACTOR EVALUATION FOR CLASS II GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site	Overall Potential for Drinking Water Beneficial Use[a]	Potential for Drinking Water Beneficial Use Based on Individual Site-Specific Factors[b]							
		Aquifer Thickness	Depth to Groundwater	Actual Measured TDS Levels	Actual Groundwater Yield	Proximity to Saltwater	Historic and Current Use	Existing Institutional Controls on Use	Cost of Cleanup to Federal Drinking Water Standards
IR-09	**LOW**	Low	Low	High	High	Low	Low	Low	Low
IR-16	**LOW**	Low	Low	High	High	Medium	Low	Low	Low
IR-17	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-32	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-33 North	**LOW**	Low	Low	High	High	Low	Low	Low	Low
IR-33 South	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-34	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-37	**LOW**	Low	Low	High	High	High	Low	Low	Low
IR-44	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-48	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-53	**LOW**	Low	Low	High	High	Low	Low	Low	Low
IR-55	**LOW**	Low	Low	Low	High	Low	Low	Low	Low
IR-65	**LOW**	Low	Low	Low	High	Low	Low	Low	Low
IR-66	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-67	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-68	**LOW**	Low	Low	Medium	High	Low	Low	Low	Low
IR-69	**LOW**	Low	Low	Medium	High	Medium	Low	Low	Low
IR-70	**LOW**	Low	Low	Low	High	Low	Low	Low	Low

Notes:

a The overall potential for drinking water beneficial use was determined by considering the individual site-specific factors together.

b "Low" indicates that, based on this site-specific factor alone, groundwater at the site has a low potential to be used as a drinking water source. "Medium" indicates that, based on this site-specific factor alone, groundwater at the site has a medium potential to be used as a drinking water source. "High" indicates that, based on this site-specific factor alone, groundwater at the site has a high potential to be used as a drinking water source.

IR Installation Restoration

TDS Total dissolved solids

TABLE 2-4: HISTORY OF IDENTIFYING AND EVALUATING FURTHER ACTIONS AT SOIL SITES IN PARCEL D
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site	Remediation or De Minimis Area	Identifying Action
IR-08	RA 8-4	**FS:** Two areas at IR-08 (RA 8-1 and RA8-2) were identified for further action based on arsenic, benzo(a)pyrene, and Aroclor-1260. RA 8-4 (boring IR08B018A) was not specifically identified. IR-08 was identified as requiring action based on a the spill of PCB-containing waste oil onto soil during construction of Building 606 in 1988. IR-08 is now part of Parcel E, although RA 8-4 is in Parcel D. The Navy conducted an interim removal action at IR-08 in an area that is now part of Parcel E. About 1,255 cubic yards of soil was excavated to depths ranging from 3 to 10 feet bgs from an area measuring 50 by 150 feet (Barajas 2007). **RMR:** Based on site-specific conditions and the RMR criteria, no remedial action recommended at IR-08B018A. **TCRA SAP:** The Navy proposed additional investigation based on the detection Aroclor-1260 in one sample from location IR08B018A. **TCRA CR 1:** Excavated 13 cubic yards of soil; maximum depth 3 feet bgs.
IR-09	RA 9-1	**FS:** RA 9-1 (borings IR09B001 through IR09B009 and IR09PPY1) identified as requiring action for arsenic, beryllium, lead, nickel, PAHs, and PCBs. **RMR:** Based on site-specific conditions and the RMR criteria, no remedial action recommended for arsenic, beryllium, lead, nickel, PAHs, and PCBs; however, agencies requested further investigation for hexavalent chromium at four soil borings (IR09B003, IR09B006, IR09B007, and IR09B011) in which total chromium concentrations exceeded the sample-specific HPAL. **TCRA SAP:** The four soil borings identified in the RMR as requiring further investigation were designated as new *de minimis* areas: DM 6864 (IR09B003), DM 6965 (IR09B006), DM 6967 (IR09B007), and DM 7167 (IR09B011). Delineation sampling concluded that no remedial action was required for hexavalent chromium. **TCRA CR 1:** Analysis of TCRA samples did not detect hexavalent chromium or total chromium at concentrations above the TCRA industrial cleanup goals. No excavation performed.
	RA 9-2	**FS:** RA 9-2 (borings IR09B016 and IR09B017) identified as requiring action for arsenic and PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action required for arsenic and PAHs.
	RA 9-3	**FS:** RA 9-3 (borings IR09B019, IR09B020, IR09B022, IR09B023, IR09B023A, IR09B024, IR09MW35A, IR09P35AA, and IR09P35AB) identified as requiring action for metals. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action required for metals.
	DM 6864	**FS:** Identified as part of RA 9-1 (above). **RMR:** Redesignated as the areas surrounding boring IR09B003 requiring further investigation for hexavalent chromium. **TCRA SAP:** Delineation sampling concluded that no remedial action was required for hexavalent chromium. **TCRA CR 1:** Analysis of TCRA samples did not detect hexavalent chromium or total chromium at concentrations above TCRA industrial cleanup goals. No excavation performed.

TABLE 2-4: HISTORY OF IDENTIFYING AND EVALUATING FURTHER ACTIONS AT SOIL SITES IN PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site	Remediation or De Minimis Area	Identifying Action
	DM 6965	**FS:** Identified as part of RA 9-1 (above). **RMR:** Redesignated as the areas surrounding boring IR09B006 requiring further investigation for hexavalent chromium. **TCRA SAP:** Delineation sampling concluded that no remedial action was required for hexavalent chromium. **TCRA CR 1:** Analysis of TCRA samples did not detect hexavalent chromium or total chromium at concentrations above TCRA industrial cleanup goals. No excavation performed.
	DM 6967	**FS:** Identified as part of RA 9-1 (above). **RMR:** Redesignated as the areas surrounding boring IR09B007 requiring further investigation for hexavalent chromium. **TCRA SAP:** Delineation sampling concluded that no remedial action was required for hexavalent chromium. **TCRA CR 1:** Analysis of TCRA samples did not detect hexavalent chromium or total chromium at concentrations above TCRA industrial cleanup goals. No excavation performed.
IR-09 (cont.)	DM 7167	**FS:** Identified as part of RA 9-1 (above). **RMR:** Redesignated as the areas surrounding boring IR09B011 requiring further investigation for hexavalent chromium. **TCRA SAP:** Delineation sampling concluded that no remedial action was required for hexavalent chromium. **TCRA CR 1:** Analysis of TCRA samples did not detect hexavalent chromium or total chromium at concentrations above TCRA industrial cleanup goals. No excavation performed.
IR-16	NA	**FS:** Identified arsenic, lead, and PCBs as requiring remediation. **EE Removal Action:** EE-15/16, an irregular-shaped area approximately 990 square feet, was excavated to a depth of 2 feet bgs. **RMR:** Based on previous removal actions (EE-15/16), site-specific conditions, and the RMR criteria, no further remedial action recommended for arsenic, lead, and PCBs.
IR-17	NA	**FS:** Identified arsenic, lead, and PCBs as requiring remediation. **TCRA CR 2:** Nine stockpiles (SPD-23 through SPD-31) within and in close proximity to IR-17 were removed as part of the TCRA conducted in 2004. The stockpiles were over-excavated by 0.5 foot bgs because they were located on unpaved soil, and confirmation samples were collected at the bottom of the excavation footprints. Analytical results for benzo(a)pyrene from the confirmation samples collected at SPD-23 and SPD-31 exceeded the TCRA screening criterion. In addition, a fuel line area identified in TCRA CR 1 south of IR-17(DM BK32) was excavated as part of TCRA CR 2 to remove PAH and petroleum contamination in soil. This excavation was 35 feet wide by 110 feet long by 10 feet deep, and approximately 1,759 cubic yards of soil was removed. All analytical results for sidewall and bottom confirmation samples collected from this excavation were below TCRA screening criteria.

IR Site	Remediation or De Minimis Area	Identifying Action
IR-22	DM 9654	**FS:** DM 9654 (test pit PA45TA09) identified as requiring remedial action for PAHs. **Parcel D RMR:** Due to parcel boundary changes, DM 9654 is now in site IR-57 of Parcel C. **Parcel C RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PAHs.
	DM 9562	**FS:** DM 9562 (boring IR22B014) identified as requiring action for beryllium. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for beryllium.
	DM 9752	**FS:** DM 9752 (boring IR22B003) identified as requiring action for arsenic. **Parcel D RMR:** Due to parcel boundary changes, DM 9752 is now in IR-57 of Parcel C.
	DM 9759	**FS:** DM 9759 (boring IR22B012) identified as requiring action for PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PAHs.
	DM 10956	**FS:** DM 10956 (boring IR51B032) identified as requiring action for PCBs and PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PCBs or PAHs.
IR-32	DM 11367	**FS:** DM 11367 (boring PA32B003) identified as requiring action for PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PAHs.
IR-33	RA 33N-1	**FS:** RA 33N-1 (borings IR33B069, IR33B070, IR33B091, and IR33MW61A) identified as requiring action for PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PAHs.
	DM 7353	**FS:** DM 7353 (boring IR33B105) identified as requiring action for hexavalent chromium. **EE Removal Action:** EE-12, a triangular area approximately 34 by 25 by 28 feet, was excavated to a depth of 10 feet bgs. Approximately 160 cubic yards was disposed of off site. **RMR:** Based on the previous removal action (EE-12), site-specific conditions, and RMR criteria, no further remedial action recommended for hexavalent chromium.
	DM 7453	**FS:** DM 7453 (surface sample PA33SS11) identified as requiring action for lead. **EE Removal Action:** EE-12, a triangular area approximately 34 by 25 by 28 feet, was excavated to a depth of 10 feet bgs. **RMR:** Based on the previous removal action (EE-12), site-specific conditions, and RMR criteria, no further remedial action recommended for lead.
	DM 7560	**FS:** DM 7560 (boring IR33B087) identified as requiring action for hexavalent chromium. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for hexavalent chromium.
	DM 7657	**FS:** DM 7657 (boring IR33B062) identified as requiring further action for arsenic and beryllium. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic or beryllium.

TABLE 2-4: HISTORY OF IDENTIFYING AND EVALUATING FURTHER ACTIONS AT SOIL SITES IN PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site	Remediation or De Minimis Area	Identifying Action
IR-33 (cont.)	RA 33S-1	**FS:** RA 33S-1(borings IR33B092 and IR33B094) identified as requiring action for arsenic, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, PAHs, and PCBs.
	RA 33S-2	**FS:** RA 33S-2 (boring PA33B053) identified as requiring action for arsenic, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, PAHs, and PCBs.
	RA 33S-3	**FS:** RA 33S-3 (boring IR33B096) identified as requiring action for PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PAHs.
	DM 8169	**FS:** DM 8169 (surface sample PA33SS57) identified as requiring action for hexavalent chromium. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for hexavalent chromium.
IR-34	DM 8258	**FS:** DM 8258 (boring IR34B023) identified as requiring action for PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PAHs.
IR-35	RA 35-1	**FS:** RA 35-1 (surface samples IR35SS14, IR35SS15, and IR35SS16) identified as requiring action for PAHs and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PAHs and PCBs.
	DM 9363	**FS:** DM 9363 (surface sample PA35SS06) identified as requiring action for PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PCBs.
IR-37	RA 37-1	**FS:** RA 37-1 (borings IR37B014, IR37B015, and IR37B017 and surface sample PA37SS09) identified as requiring action for PAHs and PCBs. **EE Removal Action:** EE-14, an area approximately 26 by 13 feet, was excavated to a depth of 3 feet bgs. **RMR:** Based on the previous removal action (EE-14), no further remedial action recommended for PAHs; however, further investigation required for manganese. **TCRA SAP:** Determined further investigation was required for manganese and PCBs. Delineation sampling concluded no further remedial action recommended for manganese; however, further action was required for PCBs. **TCRA CR 1:** Excavated 25 cubic yards of soil; maximum depth of 4 feet bgs.
	RA 37-2	**FS:** RA 37-2 (borings IR37B010 and IR37B013) identified as requiring action for arsenic, beryllium, nickel, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no action recommended for arsenic, beryllium, PAHs, and PCBs; however, further action required for antimony. **TCRA SAP:** Determined further investigation required for antimony. Delineation sampling concluded further remedial action recommended for antimony. **TCRA CR 1:** Excavated 44 cubic yards of soil; maximum depth of 8 feet bgs.

TABLE 2-4: HISTORY OF IDENTIFYING AND EVALUATING FURTHER ACTIONS AT SOIL SITES IN PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site	Remediation or De Minimis Area	Identifying Action
IR-37 (cont.)	DM 6671	**RMR:** DM 6671 identified in RMR as the area surrounding surface sample IR37SS08 requiring further investigation for manganese. **TCRA SAP:** Determined further investigation required for manganese. Delineation sampling concluded no remedial action recommended for manganese. **TCRA CR 1:** Analysis of TCRA samples indicated that concentrations of manganese are due to the presence of chert or chert fragments. No excavation recommended.
	DM 6771	**RMR:** DM 6771 identified in the RMR as the area surrounding boring IR37B021 requiring further investigation for manganese. **TCRA SAP:** Determined further investigation required for manganese. Delineation sampling concluded no remedial action recommended for manganese. **TCRA CR 1:** Analysis of TCRA samples did not detect manganese at concentrations above TCRA cleanup goals. No excavation recommended.
IR-44	NA	**FS:** Identified no areas requiring action.
IR-45	NA	**FS:** Areas requiring action are identified for the IR site in which the steam lines are physically located with petroleum hydrocarbon compounds, including PAHs, as chemicals of concern. **TCRA:** Removed and disposed of 2,100 feet of petroleum-contaminated steam line and closed 14,500 feet of steam line in place.
IR-48	NA	**FS:** Identified no areas requiring action.
IR-50	NA	**FS:** Areas requiring action are identified for the IR site in which the storm and sanitary sewer lines are physically located. **Removal Action:** Cleaned out and disposed of 1,200 tons of sediments removed from the storm drain system.
IR-51	NA	**FS:** Areas requiring action are identified for the IR site in which the former transformer sites are physically located. **Cleanup Action:** 1988 action removed 12 transformers from Parcel D. In addition, 48 transformers stored in the yard adjacent to Buildings 524 were removed and disposed of off site.
IR-53	RA 53-1	**FS:** RA 53-1 (borings IR53B019 through IR53B026 and surface samples PA53SS09 and PA53SS10) identified as requiring action for arsenic, lead, and PCBs. **EE Removal Action:** EE-15/16, an irregular-shaped area approximately 990 square feet, was excavated to a depth of 2 feet bgs. **RMR:** Based on previous removal actions (EE-15/16), site-specific conditions, and current RMR criteria, no further remedial action recommended for arsenic, lead, and PCBs.
	RA 53-2	**FS:** RA 53-2 (borings IR53B013 through IR53B017 and surface samples PA53SS03, PA53SS04, and PA53SS12) identified as requiring action for arsenic, beryllium, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, beryllium, PAHs, and PCBs.
	RA 53-3	**FS:** RA 53-3 (borings IR53B018 and IR53B018A) identified as requiring action for arsenic, beryllium, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, beryllium, and PCBs. However, a new DM area (DM 11260) surrounding boring IR53B018A determined to require further investigation for PAHs.

TABLE 2-4: HISTORY OF IDENTIFYING AND EVALUATING FURTHER ACTIONS AT SOIL SITES IN PARCEL D (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site	Remediation or De Minimis Area	Identifying Action
IR-53 (cont.)	DM 11260	**RMR:** Identified as the area surrounding boring IR53B018A requiring further investigation for PAHs. **TCRA SAP:** Determined further investigation required for PAHs. Delineation sampling confirmed that further action required for PAHs. **TCRA CR 1:** Excavated 6 cubic yards of soil; maximum depth of 3 feet bgs.
IR-55	RA 55-1	**FS:** RA 55-1 (borings IR55B019, IR55B020, IR55B021, and IR55MW02A, and test pit sample PA55TA04) identified as requiring action for arsenic, lead, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, PAHs, and PCBs; however, a new DM area (DM 10676) surrounding boring IR55B016 determined to require further investigation for lead.
	DM 10383	**FS:** DM 10383 (test pit PA55TA10) identified as requiring action for arsenic and PAHs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic and PAHs.
	DM 10676	**RMR:** Identified as the area surrounding boring IR55B016 requiring further investigation for lead. **TCRA SAP:** Determined further investigation required for lead. Delineation sampling confirmed further action required for lead. **TCRA CR 1:** Excavated 7 cubic yards of soil; maximum depth of 3 feet bgs.
IR-65	DM 8866	**FS:** DM 8866 (borings IR65B001 and IR65B004) identified as requiring further action for arsenic and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for PCBs; however, further investigation required for arsenic. **TCRA SAP:** Determined further investigation required for arsenic. Delineation sampling confirmed action required for arsenic. **TCRA CR 1:** Excavated 12 cubic yards of soil; maximum depth of 3 feet bgs.
IR-66	NA	**FS:** Identified no areas requiring action.
IR-67	NA	**FS:** Identified no areas requiring action.
IR-68	RA 68-1	**FS:** RA 68-1 (borings IR68B001 through IR68B009) identified as requiring action for arsenic, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, PAHs, and PCBs.
IR-69	RA 69-1	**FS:** RA 69-1 (borings IR69B001 through IR69B006) identified as requiring action for arsenic, lead, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no further remedial action recommended for arsenic, lead, and PCBs.
IR-70	RA 70-1	**FS:** RA 70-1 (borings IR70B005 and IR70MW04A; surface samples IR70SS01, IR70SS02, and IR70SS03; and test pit sample PA45TA11) identified as requiring action for arsenic, hexavalent chromium, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, hexavalent chromium, PAHs, and PCBs.

TABLE 2-4: HISTORY OF IDENTIFYING AND EVALUATING FURTHER ACTIONS AT SOIL SITES IN PARCEL D (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

IR Site	Remediation or De Minimis Area	Identifying Action
IR-70 (cont.)	RA 70-2	**FS:** RA 70-2 (borings IR55B022 through IR55B025, PA55B013, and IR70MW07A, and surface sample PA55SS16) identified as requiring action for arsenic, PAHs, and PCBs. **EE Removal Action:** EE-17, an irregular-shaped area approximately 420 square feet, was excavated to a depth of 7 feet bgs (approximately 110 cubic yards). **RMR:** Based on the previous removal action (EE-17), site-specific conditions, and RMR criteria, no further remedial action recommended for arsenic, PAHs, and PCBs.
	RA 70-3	**FS:** RA70-3 (boring IR70B009) identified as requiring action for arsenic, PAHs, and PCBs. **RMR:** Based on site-specific conditions and RMR criteria, no remedial action recommended for arsenic, PAHs, and PCBs.
IR-71	NA	**FS:** Identified no areas requiring action.

Notes:	The Navy's recommendations from the RMR are described in this table.
bgs	Below ground surface
DM	*De minimis*
EE	Exploratory excavation
FS	Draft Final Parcel D Feasibility Study Report, January 24, 1997
HPAL	Hunters Point ambient level
IR	Installation Restoration
NA	Not applicable
PA	Preliminary assessment
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
RA	Remediation area
RMR	Parcel D Risk Management Review Process Draft Final Report, June 20, 2000
TCRA	Time-critical removal action
TCRA CR 1	Parcel D Time-Critical Removal Action Closeout Report, September 28, 2001
TCRA CR 2	Parcel D Time-Critical Removal Action Closeout Report, May 13, 2005
TCRA SAP	Final Sampling and Analysis Plan Parcel D Soil Site Delineation, November 9, 2000

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TABLE 2-5: STOCKPILE INVENTORY

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Stockpile Identification No.	IR Site	Redevelopment Block	Approximate Location	Material	Volume (cubic yard)	Percent Vegetation (Percent)
SPD01	IR-35	DMI-1	Northwest of Building 306	Soil	1.1	10
SPD02	IR-35	DMI-1	Northern corner of Building 306	Other	5.6	0
SPD03	NA	DMI-1	Southeast of Building 368	Soil	3.7	10
SPD04	NA	DMI-1	Southeast of Building 368	Soil	5.2	10
SPD05	NA	DMI-1	Southeast of Building 384	Other	5.6	10
SPD06	IR-09	29	South of Building 402	Soil	8.3	10
SPD07	NA	39	Southeast of Building 324	Soil	250.0	80
SPD08	NA	39	Southeast of Building 324	Soil	50.1	80
SPD09	IR-37	30B	East of Building 435	Soil	1.9	60
SPD10	IR-35	DMI-1	Northwest of Building 306	Asphalt	5.6	0
SPD11	IR-35	DMI-1	Northwest of Building 369	Soil	1.9	10
SPD12	IR-37	30B	Northwest of Building 404	Soil	0.4	20
SPD13	NA	30B	West of Building 404	Soil	1.5	10
SPD14	NA	30B	North of Building 404	Soil	2.8	95
SPD15	NA	30B	North of Building 404	Soil	2.8	75
SPD16	NA	30B	North of Building 404	Soil	3.7	75
SPD17	NA	37	Southeast corner of Building 407	Soil	2.8	5
SPD18	NA	38	East of Building 407	Soil	0.6	80
SPD19	IR-70	DMI-1	West side of IR-70	Soil	10.1	95
SPD20	IR-55	DMI-1	East of Building 307	Soil	0.6	100
SPD21	NA	DMI-1	Northwest of IR55MW01A	Soil	110.0	20
SPD22	NA	DMI-1	Southwest of Building 381	Soil	1.9	10
SPD32	NA	DMI-1	Northeast of IR-17	Soil	67.9	50
SPD33	NA	DMI-1	North of IR17MW11A	Asphalt	1.9	5
SPD34	NA	DMI-1	North of IR17MW11A	Asphalt	2.8	10
SPD35	IR-69	DMI-1	Southwest of Building 523	Soil	0.9	0

TABLE 2-5: STOCKPILE INVENTORY (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Stockpile Identification No.	IR Site	Redevelopment Block	Approximate Location	Material	Volume (cubic yard)	Percent Vegetation (Percent)
SPD36	NA	DMI-1	Northeast of Building 523	Soil	5.6	75
SPD42	IR-35	DMI-1	South of Building 306	Soil	3.7	85

Notes:

IR Installation Restoration

NA Not applicable

TABLE 2-6: PARCEL D METALS DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria			Summary of the Data						
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	HPAL	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect	Percent Detect > HPAL	Percent Undetect > HPAL
Aluminum	762	761	99.87	1.1	28,400	NA	295	62,100	19,230	20,200	11,014	NA	NA
Antimony	771	258	33.46	0.1	40.7	9.05	0.26	62.4	3.83	2.40	4.92	7.36	2.14
Arsenic*	824	622	75.49	0.18	9.4	11.1	0.33	47.2	4.52	3.70	3.80	3.54	0.00
Barium	785	784	99.87	0.02	52	314	3.5	2,510	151	107	208	8.67	0.00
Beryllium	785	284	36.18	0.008	1.3	0.71	0.09	1.3	0.413	0.370	0.211	8.100	8.78
Cadmium	784	212	27.04	0.01	2.4	3.14	0.03	5.3	1.12	0.975	0.840	3.3	0.00
Calcium	759	748	98.55	1.1	8,210	NA	155	270,000	15,882	13,900	17,680	NA	NA
Chromium	831	831	100.00	0.049	10.5	21.5 to 1,744	5.7	2,040	186	106	250	3.97	All Detected
Chromium VI	332	52	15.66	0.05	3.8	NA	0.056	4.9	0.599	0.230	0.986	NA	NA
Cobalt	785	772	98.34	0.075	45.2	6.03 to 164	1.5	383	31.9	28.9	26.6	2.85	0.00
Copper	785	719	91.59	0.04	61.8	124	1.8	3,630	71.1	51.7	164	7.93	0.00
Iron	759	758	99.87	0.75	38,700	NA	3,520	138,000	33,843	35,300	14,698	NA	NA
Lead*	804	745	92.66	0.091	20.8	8.99	0.34	920	33.0	6.10	102	35.44	0.00
Magnesium	788	784	99.49	0.77	12,100	NA	413	243,000	37,505	20,100	47,807	NA	NA
Manganese*	831	830	99.88	0.02	326	1431	29.3	11,900	1,068	854	1,107	16.63	0.00
Mercury	784	314	40.05	0.005	0.95	2.28	0.0042	15.2	0.305	0.125	1.18	1.27	0.00
Molybdenum	756	84	11.11	0.08	11.6	2.68	0.21	34.6	2.88	1.50	4.91	26.19	2.53
Nickel	785	783	99.75	0.076	23.2	14.4 to 28,898	6	6,340	299	86.5	557	0.64	0.00
Potassium	759	660	86.96	1.5	2,200	NA	32.8	4,110	1,025	898	586	NA	NA
Selenium	774	75	9.69	0.16	6.4	1.95	0.17	4.9	1.10	0.890	0.766	14.67	0.72
Silver	785	30	3.82	0.06	12.1	1.43	0.16	3.1	0.912	0.650	0.707	23.330	5.83
Sodium	754	455	60.34	2.5	3,350	NA	44.1	6,070	635	378	821	NA	NA
Thallium	778	66	8.48	0.11	5.5	0.81	0.36	21.5	2.20	1.50	2.76	72.73	10.39
Vanadium	781	780	99.87	0.045	13	117	2.4	217	73.4	70.9	40.2	16.28	0.00
Zinc	785	767	97.71	0.06	120	110	11.1	2,530	100	67.9	182	15.65	5.56

Note:

* Analyte is a chemical of concern as determined by the revised baseline human health risk assessment conducted for Parcel D (see Appendix B).

HPAL Hunters Point ambient level

mg/kg Milligram per kilogram

NA Not available

TABLE 2-7: PARCEL D METALS DATA SUMMARY TABLE, SOIL (GREATER THAN 10 FEET BELOW GROUND SURFACE)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria			Summary of the Data						
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	HPAL	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect	Percent Detect > HPAL	Percent Undetect > HPAL
Aluminum	419	419	100.00	1.1	72	NA	766	66,700	20,094	20,800	11,897	NA	All Detected
Antimony	407	135	33.17	0.1	32.4	9.05	0.34	83	4.87	2.10	10.42	11.85	2.57
Arsenic*	419	300	71.60	0.2	5	11.1	0.34	36.7	4.45	3.80	3.56	3.33	0.00
Barium	419	419	100.00	0.033	46	314	2.1	2,260	107	78.7	139	3.58	All Detected
Beryllium	419	140	33.41	0.007	1.2	0.71	0.02	1.3	0.386	0.355	0.196	3.57	2.15
Cadmium	419	144	34.37	0.01	2	3.14	0.04	3.8	0.86	0.655	0.696	3.47	0.00
Calcium	418	406	97.13	1.6	8,360	NA	114	310,000	25,999	14,700	39,903	NA	NA
Chromium	419	419	100.00	0.049	11.2	21.5 to 1,744	18.5	2,710	214	113	300	2.86	All Detected
Chromium VI	112	22	19.64	0.05	6.5	NA	0.07	13	1.008	0.375	2.635	NA	NA
Cobalt	419	413	98.57	0.082	46	6.03 to 164	3.6	200	34.1	29	28.1	4.60	0.00
Copper	419	398	94.99	0.04	66.8	124	1.9	739	45.9	41.7	48	2.01	0.00
Iron	418	418	100.00	1.1	26	NA	5,690	84,100	33,947	35,050	14,498	NA	All Detected
Lead*	419	356	84.96	0.1	5.2	8.99	0.49	1,180	12.4	4.70	69	17.98	0.00
Magnesium	418	417	99.76	0.85	2,320	NA	1,650	260,000	43,527	18,500	56,041	NA	NA
Manganese*	419	419	100.00	0.016	3.6	1,431	48.4	5,190	787	707	584	9.55	All Detected
Mercury	413	128	30.99	0.003	0.23	2.28	0.01	2.8	0.147	0.09	0.26	0.78	0.00
Molybdenum	414	50	12.08	0.08	7.7	2.68	0.11	6.7	1.42	1.10	1.17	8.00	1.37
Nickel	419	419	100.00	0.098	11.2	14.4 to 28,898	15.7	4,460	367	75.9	631	0.24	All Detected
Potassium	418	381	91.15	2	2,690	NA	61.4	5,950	1,374	1130	974	NA	NA
Selenium	414	34	8.21	0.21	6	1.95	0.39	4.5	1.29	1.100	0.888	11.76	0.79
Silver	419	14	3.34	0.049	2.4	1.43	0.098	3	1.318	0.725	1.066	35.71	0.99
Sodium	413	318	77.00	2.8	6,580	NA	30.6	10,900	2,362	1,665	2,136	NA	NA
Thallium	419	42	10.02	0.1	7.9	0.81	0.49	7.4	2.32	1.90	1.62	85.71	7.43
Vanadium	418	418	100.00	0.065	11	117	7.4	318	73.0	65.4	42.2	15.31	All Detected
Zinc	419	416	99.28	0.06	32.7	110	13.2	1,060	70	60.2	78	5.53	0.00

Note:

*	Analyte is a chemical of concern as determined by the revised baseline human health risk assessment conducted for Parcel D (see Appendix B).
HPAL	Hunters Point ambient level
mg/kg	Milligram per kilogram
NA	Not available

TABLE 2-8: PARCEL D VOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Number Analyzed	Number Detected	Percent Detected	Comparison of Detection Limits to Criteria: Minimum Detection Limit (mg/kg)	Comparison of Detection Limits to Criteria: Maximum Detection Limit (mg/kg)	Summary of the Data: Minimum Detected (mg/kg)	Summary of the Data: Maximum Detected (mg/kg)	Summary of the Data: Average Detected (mg/kg)	Summary of the Data: Median Detected (mg/kg)	Summary of the Data: Standard Deviation of Detect
1,1,1,2-Tetrachloroethane	14	0	0.00	0.0045	0.0073	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	656	8	1.22	0.001	1.5	0.002	0.058	0.011	0.004	0.018
1,1,2,2-Tetrachloroethane	656	1	0.15	0.001	1.5	0.007	0.007	0.007	0.007	NA
1,1,2-Trichloro-1,2,2-Trifluoroethane	14	0	0.00	0.0045	0.015	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
1,1-Dichloroethane	656	4	0.61	0.001	1.5	0.001	0.003	0.002	0.002	0.000
1,1-Dichloroethene	656	1	0.15	0.001	1.5	0.003	0.003	0.003	0.003	NA
1,1-Dichloropropene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
1,2,3-Trichlorobenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	14	0	0.00	0.0045	0.015	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	719	2	0.28	0.0045	120	0.0006	0.00083	0.001	0.001	0.000
1,2,4-Trimethylbenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
1,2-Dibromo-3-Chloropropane	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
1,2-Dibromoethane	13	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	718	0	0.00	0.0045	120	ND	ND	ND	ND	ND
1,2-Dichloroethane	656	2	0.30	0.001	1.5	0.001	0.01	0.006	0.006	0.005
1,2-Dichloroethene (Total)	642	1	0.16	0.001	1.5	0.013	0.013	0.013	0.013	NA
1,2-Dichloropropane	656	2	0.30	0.001	1.5	0.001	0.002	0.002	0.002	0.000
1,3,5-Trimethylbenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	718	0	0.00	0.0045	120	ND	ND	ND	ND	ND
1,3-Dichloropropane	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	718	0	0.00	0.0045	120	ND	ND	ND	ND	ND
2,2-Dichloropropane	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
2-Butanone	649	15	2.31	0.0009	1.5	0.002	0.06	0.018	0.014	0.017
2-Chlorotoluene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
2-Hexanone	652	1	0.15	0.001	1.5	0.001	0.001	0.001	0.001	NA
4-Chlorotoluene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	652	13	1.99	0.001	1.5	0.001	0.026	0.009	0.006	0.008
Acetone	656	29	4.42	0.0005	1.5	0.002	0.16	0.056	0.036	0.047
Benzene	719	22	3.06	0.0006	1.5	0.0003	0.12	0.016	0.001	0.033
Bromobenzene	14	0	0.00	0.0045	0.0073	ND	ND	ND	ND	ND

TABLE 2-8: PARCEL D VOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE) (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Number Analyzed	Number Detected	Percent Detected	Comparison of Detection Limits to Criteria: Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Summary of the Data: Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
Bromochloromethane	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
Bromodichloromethane	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Bromoform	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Bromomethane	656	1	0.15	0.001	1.5	0.002	0.002	0.002	0.002	NA
Carbon Disulfide	652	15	2.30	0.0007	1.5	0.0005	0.03	0.006	0.003	0.007
Carbon Tetrachloride	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Chlorobenzene	656	1	0.15	0.001	1.5	0.003	0.003	0.003	0.003	NA
Chloroethane	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Chloroform	656	7	1.07	0.001	1.5	0.001	0.007	0.003	0.002	0.000
Chloromethane	656	3	0.46	0.001	1.5	0.00072	0.0015	0.001	0.001	0.000
Cis-1,2-Dichloroethene	14	0	0.00	0.0045	0.0073	ND	ND	ND	ND	ND
Cis-1,3-Dichloropropene	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Dibromochloromethane	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Dibromomethane	14	0	0.00	0.0045	0.0073	ND	ND	ND	ND	ND
Dichlorodifluoromethane	14	0	0.00	0.009	0.015	ND	ND	ND	ND	ND
Ethylbenzene	719	10	1.39	0.0006	1.5	0.00023	0.76	0.082	0.006	0.226
Isopropylbenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
M,P-Xylenes	60	4	6.67	0.0011	0.34	0.00086	2.3	0.604	0.058	0.980
Methylene Chloride	656	6	0.91	0.001	1.5	0.001	1.2	0.219	0.014	0.440
Naphthalene	820	41	5.00	0.0045	120	0.018	2.7	0.316	0.070	0.616
N-Butylbenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
O-Xylene	60	4	6.67	0.0011	0.34	0.00066	0.62	0.166	0.022	0.262
Para-Isopropyl Toluene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
Propylbenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
Sec-Butylbenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
Styrene	652	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Tert-Butyl Methyl Ether	57	0	0.00	0.0043	0.015	ND	ND	ND	ND	ND
Tert-Butylbenzene	10	0	0.00	0.0045	0.0066	ND	ND	ND	ND	ND
Tetrachloroethene	656	18	2.74	0.001	1.5	0.001	0.11	0.013	0.003	0.026
Toluene	719	95	13.21	0.0006	1.5	0.00019	0.15	0.010	0.002	0.021
Trans-1,2-Dichloroethene	14	0	0.00	0.0045	0.0073	ND	ND	ND	ND	ND

TABLE 2-8: PARCEL D VOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE) (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
Trans-1,3-Dichloropropene	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Trichloroethene	656	9	1.37	0.001	1.5	0.001	0.036	0.010	0.006	0.011
Trichlorofluoromethane	14	0	0.00	0.0045	0.0073	ND	ND	ND	ND	ND
Vinyl Acetate	184	0	0.00	0.001	0.066	ND	ND	ND	ND	ND
Vinyl Chloride	656	0	0.00	0.001	1.5	ND	ND	ND	ND	ND
Xylene (Total)	661	32	4.84	0.0006	1.5	0.0005	3	0.109	0.006	0.520

Notes:

mg/kg Milligram per kilogram

ND Nondetect

NA Not available

TABLE 2-9: PARCEL D VOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (GREATER THAN 10 FEET BELOW GROUND SURFACE)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
1,1,1,2-Tetrachloroethane	5	0	0.00	0.0055	0.0066	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	374	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-Trifluoroethane	5	0	0.00	0.0062	0.012	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	376	1	0.27	0.0055	0.055	0.009	0.009	0.009	0.009	NA
1,1-Dichloroethane	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
1,1-Dichloroethene	376	1	0.27	0.0055	0.055	0.002	0.002	0.002	0.002	NA
1,1-Dichloropropene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
1,2,3-Trichlorobenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	5	0	0.00	0.0062	0.012	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	375	0	0.00	0.0055	12	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
1,2-Dibromo-3-Chloropropane	4	0	0.00	0.0062	0.025	ND	ND	ND	ND	ND
1,2-Dibromoethane	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	375	0	0.00	0.0055	12	ND	ND	ND	ND	ND
1,2-Dichloroethane	376	1	0.27	0.0055	0.055	0.003	0.003	0.003	0.003	NA
1,2-Dichloroethene (Total)	371	0	0.00	0.006	0.055	ND	ND	ND	ND	ND
1,2-Dichloropropane	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	375	0	0.00	0.0055	12	ND	ND	ND	ND	ND
1,3-Dichloropropane	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	375	0	0.00	0.0055	12	ND	ND	ND	ND	ND
2,2-Dichloropropane	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
2-Butanone	373	11	2.95	0.002	0.1	0.009	0.58	0.103	0.014	0.166
2-Chlorotoluene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
2-Hexanone	371	0	0.00	0.002	0.055	ND	ND	ND	ND	ND
4-Chlorotoluene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	371	3	0.81	0.008	0.055	0.0014	0.014	0.006	0.003	0.006
Acetone	374	21	5.61	0.003	0.14	0.007	0.22	0.071	0.063	0.058
Benzene	376	10	2.66	0.0006	0.051	0.00046	0.29	0.061	0.045	0.082
Bromobenzene	5	0	0.00	0.0055	0.0066	ND	ND	ND	ND	ND
Bromochloromethane	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND

TABLE 2-9: PARCEL D VOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (GREATER THAN 10 FEET BELOW GROUND SURFACE) (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Number Analyzed	Number Detected	Percent Detected	Comparison of Detection Limits to Criteria: Minimum Detection Limit (mg/kg)	Comparison of Detection Limits to Criteria: Maximum Detection Limit (mg/kg)	Summary of the Data: Minimum Detected (mg/kg)	Summary of the Data: Maximum Detected (mg/kg)	Summary of the Data: Average Detected (mg/kg)	Summary of the Data: Median Detected (mg/kg)	Summary of the Data: Standard Deviation of Detect
Bromodichloromethane	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Bromoform	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Bromomethane	376	0	0.00	0.008	0.055	ND	ND	ND	ND	ND
Carbon Disulfide	373	51	13.67	0.0005	0.055	0.001	0.035	0.010	0.007	0.009
Carbon Tetrachloride	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Chlorobenzene	374	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Chloroethane	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Chloroform	376	4	1.06	0.0055	0.055	0.002	0.004	0.003	0.003	0.000
Chloromethane	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Cis-1,2-Dichloroethene	5	0	0.00	0.0055	0.0066	ND	ND	ND	ND	ND
Cis-1,3-Dichloropropene	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Dibromochloromethane	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Dibromomethane	5	0	0.00	0.0055	0.0066	ND	ND	ND	ND	ND
Dichlorodifluoromethane	5	0	0.00	0.011	0.013	ND	ND	ND	ND	ND
Ethylbenzene	374	1	0.27	0.0006	0.055	0.001	0.001	0.001	0.001	NA
Isopropylbenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
M,P-Xylenes	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
Methylene Chloride	376	7	1.86	0.001	0.081	0.002	0.14	0.038	0.011	0.047
N-Butylbenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
Naphthalene	375	18	4.80	0.0062	12	0.0079	0.68	0.192	0.130	0.191
O-Xylene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
Para-Isopropyl Toluene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
Propylbenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
Sec-Butylbenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
Styrene	371	0	0.00	0.006	0.055	ND	ND	ND	ND	ND
Tert-Butyl Methyl Ether	5	0	0.00	0.0055	0.0066	ND	ND	ND	ND	ND
Tert-Butylbenzene	2	0	0.00	0.0062	0.0066	ND	ND	ND	ND	ND
Tetrachloroethene	374	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Toluene	374	12	3.21	0.0006	0.051	0.00036	0.13	0.028	0.016	0.034
Trans-1,2-Dichloroethene	5	0	0.00	0.0055	0.0066	ND	ND	ND	ND	ND
Trans-1,3-Dichloropropene	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND

TABLE 2-9: PARCEL D VOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (GREATER THAN 10 FEET BELOW GROUND SURFACE) (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
Trichloroethene	376	4	1.06	0.0055	0.055	0.002	0.063	0.020	0.008	0.025
Trichlorofluoromethane	5	0	0.00	0.0055	0.0066	ND	ND	ND	ND	ND
Vinyl Acetate	6	0	0.00	0.012	0.066	ND	ND	ND	ND	ND
Vinyl Chloride	376	0	0.00	0.0055	0.055	ND	ND	ND	ND	ND
Xylene (Total)	372	10	2.69	0.0006	0.051	0.001	0.027	0.008	0.008	0.007

Notes:
mg/kg Milligram per kilogram
ND Nondetect

TABLE 2-10: PARCEL D SEMIVOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
2,2'-Oxybis(1-Chloropropane)	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	697	0	0.00	0.8	290	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	697	0	0.00	0.33	120	ND	ND	ND	ND	ND
2,4-Dichlorophenol	698	0	0.00	0.33	120	ND	ND	ND	ND	ND
2,4-Dimethylphenol	703	1	0.14	0.33	120	0.13	0.13	0.13	0.13	NA
2,4-Dinitrophenol	660	0	0.00	0.8	290	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	704	1	0.14	0.33	120	0.075	0.075	0.075	0.075	NA
2,6-Dinitrotoluene	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
2-Chloronaphthalene	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
2-Chlorophenol	703	0	0.00	0.33	120	ND	ND	ND	ND	ND
2-Methylnaphthalene	722	54	7.48	0.072	120	0.02	7.9	0.423	0.095	1.301
2-Methylphenol	697	2	0.29	0.33	120	0.028	0.33	0.179	0.179	0.151
2-Nitroaniline	703	0	0.00	0.8	290	ND	ND	ND	ND	ND
2-Nitrophenol	699	0	0.00	0.33	120	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	701	0	0.00	0.33	120	ND	ND	ND	ND	ND
3-Nitroaniline	704	0	0.00	0.8	290	ND	ND	ND	ND	ND
4,6-Dinitro-2-Methylphenol	686	0	0.00	0.8	290	ND	ND	ND	ND	ND
4-Bromophenyl-Phenylether	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
4-Chloro-3-Methylphenol	698	0	0.00	0.33	120	ND	ND	ND	ND	ND
4-Chloroaniline	705	0	0.00	0.33	120	ND	ND	ND	ND	ND
4-Chlorophenyl-Phenylether	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
4-Methylphenol	697	2	0.29	0.33	120	0.05	0.87	0.46	0.46	0.41
4-Nitroaniline	704	0	0.00	0.8	290	ND	ND	ND	ND	ND
4-Nitrophenol	702	0	0.00	0.8	290	ND	ND	ND	ND	ND
Acenaphthene	809	11	1.36	0.05	120	0.015	1	0.204	0.110	0.278
Acenaphthylene	810	4	0.49	0.05	120	0.008	0.19	0.094	0.089	0.068
Aniline	20	0	0.00	0.33	0.41	ND	ND	ND	ND	ND
Anthracene	811	28	3.45	0.05	120	0.002	0.6	0.088	0.049	0.115
Azobenzene	20	0	0.00	0.33	0.41	ND	ND	ND	ND	ND
Benzidine	20	0	0.00	0.33	0.41	ND	ND	ND	ND	ND
Benzo(a)anthracene	810	53	6.54	0.05	120	0.012	1.5	0.202	0.091	0.274
Benzo(a)pyrene*	796	61	7.66	0.05	120	0.011	4.2	0.238	0.093	0.549

TABLE 2-10: PARCEL D SEMIVOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE) (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
Benzo(b)fluoranthene*	798	80	10.03	0.05	120	0.019	13	0.368	0.095	1.457
Benzo(g,h,i)perylene	794	39	4.91	0.05	120	0.014	1.5	0.151	0.073	0.250
Benzo(k)fluoranthene	796	43	5.40	0.05	120	0.013	8.2	0.356	0.100	1.222
Benzoic Acid	171	0	0.00	1.6	17	ND	ND	ND	ND	ND
Benzyl Alcohol	165	0	0.00	0.33	3.5	ND	ND	ND	ND	ND
Bis(2-chloroethoxy)methane	705	0	0.00	0.33	120	ND	ND	ND	ND	ND
Bis(2-chloroethyl)ether	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	708	17	2.40	0.02	120	0.017	18	1.374	0.160	4.192
Butylbenzylphthalate	701	1	0.14	0.013	120	0.043	0.043	0.043	0.043	NA
Carbazole	538	9	1.67	0.33	120	0.022	0.34	0.137	0.060	0.128
Chrysene	812	95	11.70	0.05	120	0.015	4.5	0.229	0.065	0.507
Dibenz(a,h)anthracene	791	8	1.01	0.05	120	0.01	0.084	0.044	0.042	0.026
Dibenzofuran	709	22	3.10	0.33	120	0.018	0.29	0.061	0.044	0.056
Diethylphthalate	709	1	0.14	0.33	120	0.051	0.051	0.051	0.051	NA
Dimethylphthalate	704	2	0.28	0.33	120	0.089	0.17	0.130	0.130	0.041
Di-N-Butylphthalate	704	8	1.14	0.01	120	0.04	0.14	0.077	0.066	0.033
Di-N-Octylphthalate	689	0	0.00	0.33	120	ND	ND	ND	ND	ND
Fluoranthene	814	102	12.53	0.05	120	0.014	1.9	0.239	0.082	0.400
Fluorene	810	22	2.72	0.05	120	0.016	2.4	0.330	0.055	0.679
Hexachlorobenzene	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
Hexachlorobutadiene	715	0	0.00	0.0045	120	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	703	0	0.00	0.33	120	ND	ND	ND	ND	ND
Hexachloroethane	704	0	0.00	0.33	120	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	794	35	4.41	0.05	120	0.013	0.57	0.102	0.072	0.104
Isophorone	705	2	0.28	0.33	120	0.33	1.8	1.065	1.065	0.735
Nitrobenzene	705	0	0.00	0.33	120	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	20	0	0.00	0.33	0.41	ND	ND	ND	ND	ND
N-Nitroso-Di-N-Propylamine	709	0	0.00	0.33	120	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	709	0	0.00	0.053	120	ND	ND	ND	ND	ND
Pentachlorophenol	702	4	0.57	0.71	290	0.07	0.6	0.215	0.096	0.223

TABLE 2-10: PARCEL D SEMIVOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE) (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
Phenanthrene	814	125	15.36	0.05	120	0.011	11	0.332	0.092	1.153
Phenol	702	10	1.42	0.04	120	0.035	1.2	0.216	0.101	0.337
Pyrene	812	124	15.27	0.05	120	0.008	4.5	0.297	0.089	0.619

Note:

*	Analyte is a chemical of concern as determined by the revised baseline human health risk assessment conducted for Parcel D (see Appendix B).
mg/kg	Milligram per kilogram
ND	Nondetect
NA	Not available

TABLE 2-11: PARCEL D SEMIVOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (GREATER THAN 10 FEET BELOW GROUND SURFACE)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
2,2'-Oxybis(1-Chloropropane)	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	370	0	0.00	0.83	29	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2,4-Dichlorophenol	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2,4-Dimethylphenol	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2,4-Dinitrophenol	366	0	0.00	0.83	29	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2-Chloronaphthalene	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2-Chlorophenol	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
2-Methylnaphthalene	371	29	7.82	0.076	12	0.02	0.57	0.132	0.091	0.131
2-Methylphenol	370	2	0.54	0.34	12	0.036	0.037	0.0365	0.0365	0
2-Nitroaniline	370	0	0.00	0.83	29	ND	ND	ND	ND	ND
2-Nitrophenol	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
3-Nitroaniline	370	0	0.00	0.83	29	ND	ND	ND	ND	ND
4,6-Dinitro-2-Methylphenol	370	0	0.00	0.83	29	ND	ND	ND	ND	ND
4-Bromophenyl-Phenylether	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
4-Chloro-3-Methylphenol	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
4-Chloroaniline	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
4-Chlorophenyl-Phenylether	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
4-Methylphenol	370	2	0.54	0.34	12	0.045	0.049	0.047	0.047	0
4-Nitroaniline	370	0	0.00	0.83	29	ND	ND	ND	ND	ND
4-Nitrophenol	370	0	0.00	0.83	29	ND	ND	ND	ND	ND
Acenaphthene	373	5	1.34	0.063	12	0.014	0.19	0.085	0.050	0.063
Acenaphthylene	373	7	1.88	0.063	12	0.022	0.19	0.120	0.140	0.060
Aniline	0	0	0.00	0	0	ND	ND	ND	ND	ND
Anthracene	373	24	6.43	0.063	12	0.004	0.88	0.133	0.040	0.204
Azobenzene	0	0	0.00	0	0	ND	ND	ND	ND	ND
Benzidine	0	0	0.00	0	0	ND	ND	ND	ND	ND
Benzo(a)anthracene	373	29	7.77	0.063	12	0.018	3.1	0.354	0.130	0.616
Benzo(a)pyrene*	373	39	10.46	0.063	12	0.017	4.1	0.356	0.083	0.705
Benzo(b)fluoranthene*	372	33	8.87	0.063	12	0.018	1.7	0.293	0.086	0.422
Benzo(g,h,i)perylene	373	29	7.77	0.063	12	0.017	3.8	0.309	0.110	0.702
Benzo(k)fluoranthene	373	24	6.43	0.063	12	0.002	1.2	0.243	0.135	0.292

TABLE 2-11: PARCEL D SEMIVOLATILE ORGANIC COMPOUNDS DATA SUMMARY TABLE, SOIL (GREATER THAN 10 FEET BELOW GROUND SURFACE) (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detection Limits to Criteria		Summary of the Data				
Analyte	Number Analyzed	Number Detected	Percent Detected	Minimum Detection Limit (mg/kg)	Maximum Detection Limit (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Average Detected (mg/kg)	Median Detected (mg/kg)	Standard Deviation of Detect
Benzoic Acid	4	0	0.00	1.9	2	ND	ND	ND	ND	ND
Benzyl Alcohol	4	0	0.00	0.39	0.41	ND	ND	ND	ND	ND
Bis(2-chloroethoxy)methane	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Bis(2-chloroethyl)ether	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	370	2	0.54	0.022	12	1.1	1.2	1.150	1.150	0.050
Butylbenzylphthalate	370	0	0.00	0.011	12	ND	ND	ND	ND	ND
Carbazole	366	9	2.46	0.34	12	0.022	0.04	0.030	0.029	0.006
Chrysene	373	36	9.65	0.063	12	0.02	3.1	0.307	0.083	0.570
Dibenz(a,h)anthracene	373	6	1.61	0.063	12	0.031	0.57	0.184	0.082	0.187
Dibenzofuran	370	22	5.95	0.34	12	0.016	0.13	0.059	0.049	0.033
Diethylphthalate	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Dimethylphthalate	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Di-N-Butylphthalate	370	0	0.00	0.02	12	ND	ND	ND	ND	ND
Di-N-Octylphthalate	370	0	0.00	0.028	12	ND	ND	ND	ND	ND
Fluoranthene	373	52	13.94	0.063	12	0.008	5.6	0.409	0.074	0.937
Fluorene	373	21	5.63	0.063	12	0.024	0.24	0.074	0.055	0.048
Hexachlorobenzene	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Hexachlorobutadiene	372	0	0.00	0.0062	12	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Hexachloroethane	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	373	20	5.36	0.063	12	0.018	2.6	0.373	0.195	0.567
Isophorone	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
Nitrobenzene	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	0	0	0.00	0	0	ND	ND	ND	ND	ND
N-Nitroso-Di-N-Propylamine	370	0	0.00	0.34	12	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	370	0	0.00	0.054	12	ND	ND	ND	ND	ND
Pentachlorophenol	370	0	0.00	0.83	29	ND	ND	ND	ND	ND
Phenanthrene	373	51	13.67	0.063	12	0.021	3	0.244	0.110	0.475
Phenol	370	2	0.54	0.036	12	0.046	1.4	0.723	0.723	0.677
Pyrene	373	64	17.16	0.063	12	0.008	13	0.534	0.083	1.705

Notes:

* Analyte is a chemical of concern as determined by the revised baseline human health risk assessment conducted for Parcel D (see Appendix B).

mg/kg Milligram per kilogram

ND Nondetect

TABLE 2-12: PARCEL D PESTICIDES, PCBS, AND CYANIDE DATA SUMMARY TABLE, SOIL (0 TO 10 FEET BELOW GROUND SURFACE)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Number Analyzed	Number Detected	Percent Detected	Comparison of Detection Limits to Criteria: Minimum Detection Limit (mg/kg)	Comparison of Detection Limits to Criteria: Maximum Detection Limit (mg/kg)	Summary of the Data: Minimum Detected (mg/kg)	Summary of the Data: Maximum Detected (mg/kg)	Summary of the Data: Average Detected (mg/kg)	Summary of the Data: Median Detected (mg/kg)	Summary of the Data: Standard Deviation of Detect
4,4'-DDD	652	13	1.99	0.003	0.28	0.0002	0.18	0.023	0.003	0.048
4,4'-DDE	652	15	2.30	0.003	0.28	0.00002	0.079	0.013	0.003	0.021
4,4'-DDT	652	29	4.45	0.003	0.28	0.0001	0.33	0.021	0.004	0.060
Aldrin	652	2	0.31	0.0019	0.14	0.0005	0.0009	0.001	0.001	0.000
alpha-BHC	652	0	0.00	0.0019	0.14	ND	ND	ND	ND	ND
alpha-Chlordane	652	8	1.23	0.0019	1.4	0.00003	0.016	0.005	0.003	0.006
Aroclor-1016	733	0	0.00	0.012	1.8	ND	ND	ND	ND	ND
Aroclor-1221	733	0	0.00	0.012	3.5	ND	ND	ND	ND	ND
Aroclor-1232	733	1	0.14	0.012	1.8	0.084	0.084	0.084	0.084	NA
Aroclor-1242	733	1	0.14	0.012	1.8	0.022	0.022	0.022	0.022	NA
Aroclor-1248	733	0	0.00	0.012	1.8	ND	ND	ND	ND	ND
Aroclor-1254	733	16	2.18	0.012	2.8	0.004	0.68	0.094	0.041	0.157
Aroclor-1260	739	100	13.53	0.012	2.8	0.0081	0.98	0.147	0.078	0.182
beta-BHC	652	1	0.15	0.0019	0.14	0.0002	0.0002	0.000	0.000	NA
Cyanide	62	7	11.29	0.04	0.63	0.04	2.2	0.377	0.080	0.745
delta-BHC	652	3	0.46	0.0019	0.14	0.002	0.006	0.004	0.004	0.000
Dieldrin	652	8	1.23	0.003	0.28	0.00002	0.019	0.005	0.001	0.007
Endosulfan I	652	3	0.46	0.0019	0.14	0.009	0.014	0.011	0.010	0.000
Endosulfan II	652	1	0.15	0.002	0.28	0.002	0.002	0.002	0.002	NA
Endosulfan Sulfate	652	1	0.15	0.003	0.28	0.0009	0.0009	0.001	0.001	NA
Endrin	653	5	0.77	0.003	0.28	0.00003	0.002	0.001	0.000	0.000
Endrin Aldehyde	521	6	1.15	0.003	0.18	0.0003	0.005	0.002	0.002	0.000
Endrin Ketone	652	6	0.92	0.003	0.28	0.0003	0.015	0.005	0.004	0.005
gamma-BHC (lindane)	652	0	0.00	0.0019	0.14	ND	ND	ND	ND	ND
gamma-Chlordane	652	9	1.38	0.0019	1.4	0.00005	0.01	0.003	0.001	0.003
Heptachlor	652	2	0.31	0.0003	0.14	0.0002	0.002	0.001	0.001	0.000
Heptachlor Epoxide	652	5	0.77	0.0003	0.14	0.0003	0.004	0.001	0.001	0.000
Methoxychlor	652	1	0.15	0.004	1.4	0.0007	0.0007	0.001	0.001	NA
Toxaphene	652	0	0.00	0.097	8.8	ND	ND	ND	ND	ND

Notes:

BHC	Benzene hexachloride	mg/kg	Milligram per kilogram
DDD	Dichlorodiphenyldichloroethane	NA	Not available
DDE	Dichlorodiphenyldichloroethene	ND	Nondetect
DDT	Dichlorodiphenyltrichloroethane	PCB	Polychlorinated biphenyl

TABLE 2-13: PARCEL D PESTICIDES, PCBS, AND CYANIDE DATA SUMMARY TABLE, SOIL (GREATER THAN 10 FEET BELOW GROUND SURFACE)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Number Analyzed	Number Detected	Percent Detected	Comparison of Detection Limits to Criteria: Minimum Detection Limit (mg/kg)	Comparison of Detection Limits to Criteria: Maximum Detection Limit (mg/kg)	Summary of the Data: Minimum Detected (mg/kg)	Summary of the Data: Maximum Detected (mg/kg)	Summary of the Data: Average Detected (mg/kg)	Summary of the Data: Median Detected (mg/kg)	Summary of the Data: Standard Deviation of Detect
4,4'-DDD	388	1	0.26	0.003	0.024	0.00007	0.00007	0.000	0.000	NA
4,4'-DDE	388	0	0.00	0.003	0.024	ND	ND	ND	ND	ND
4,4'-DDT	388	1	0.26	0.003	0.024	0.002	0.002	0.002	0.002	NA
Aldrin	388	3	0.77	0.002	0.012	0.0006	0.001	0.001	0.001	0.000
alpha-BHC	388	0	0.00	0.002	0.012	ND	ND	ND	ND	ND
alpha-Chlordane	388	1	0.26	0.002	0.11	0.003	0.003	0.003	0.003	NA
Aroclor-1016	406	0	0.00	0.018	0.24	ND	ND	ND	ND	ND
Aroclor-1221	406	0	0.00	0.018	0.48	ND	ND	ND	ND	ND
Aroclor-1232	406	0	0.00	0.018	0.24	ND	ND	ND	ND	ND
Aroclor-1242	406	0	0.00	0.018	0.24	ND	ND	ND	ND	ND
Aroclor-1248	406	0	0.00	0.018	0.24	ND	ND	ND	ND	ND
Aroclor-1254	407	2	0.49	0.018	0.24	0.87	0.871	0.871	0.871	0.000
Aroclor-1260	406	1	0.25	0.018	0.24	0.085	0.085	0.085	0.085	NA
beta-BHC	388	1	0.26	0.002	0.012	0.0002	0.0002	0.000	0.000	NA
Cyanide	45	4	8.89	0.05	0.67	0.08	0.16	0.115	0.110	0.032
delta-BHC	388	0	0.00	0.002	0.012	ND	ND	ND	ND	ND
Dieldrin	388	2	0.52	0.003	0.024	0.0003	0.002	0.001	0.001	0.000
Endosulfan I	388	1	0.26	0.002	0.012	0.006	0.006	0.006	0.006	NA
Endosulfan II	388	0	0.00	0.003	0.024	ND	ND	ND	ND	ND
Endosulfan Sulfate	388	0	0.00	0.003	0.024	ND	ND	ND	ND	ND
Endrin	388	2	0.52	0.003	0.024	0.0009	0.002	0.001	0.001	0.000
Endrin Aldehyde	365	1	0.27	0.003	0.024	0.002	0.002	0.002	0.002	NA
Endrin Ketone	388	1	0.26	0.003	0.024	0.00006	0.00006	0.000	0.000	NA
gamma-BHC (lindane)	388	1	0.26	0.002	0.012	0.001	0.001	0.001	0.001	NA
gamma-Chlordane	388	1	0.26	0.002	0.11	0.00002	0.00002	0.000	0.000	NA
Heptachlor	388	1	0.26	0.002	0.012	0.001	0.001	0.001	0.001	NA
Heptachlor Epoxide	388	0	0.00	0.0004	0.012	ND	ND	ND	ND	ND
Methoxychlor	388	0	0.00	0.017	0.12	ND	ND	ND	ND	ND
Toxaphene	388	0	0.00	0.11	1.2	ND	ND	ND	ND	ND

Notes:

BHC	Benzene hexachloride	mg/kg	Milligram per kilogram
DDD	Dichlorodiphenyldichloroethane	NA	Not available
DDE	Dichlorodiphenyldichloroethene	ND	Nondetect
DDT	Dichlorodiphenyltrichloroethane	PCB	Polychlorinated biphenyl

TABLE 2-14: PARCEL D METALS DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections							Comparison of HGALs				
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects	HGAL Screening Level	Number of Detects Exceeding HGAL	Percent of Detects Exceeding HGAL	Number of Nondetects with Limits Exceeding HGAL	Percent of Nondetects with Limits Exceeding HGAL
Aluminum	215	29	13.49	8.7	315	14.3	53,800	3,273	313	10,222	NA	NA	NA	NA	NA
Antimony	213	15	7.04	0.04	69	0.44	34.2	14.39	14.20	11.37	43.26	0	0.00	1	0.51
Arsenic	214	95	44.39	1.3	31	1.4	76.3	10.7	5.7	13.1	27.3	10	10.53	1	0.84
Barium	213	207	97.18	0.3	63.9	7.7	952	111	61.9	137	504.2	7	3.38	0	0.00
Beryllium	213	13	6.10	0.1	2	0.2	3.1	1.0	0.5	0.8	1.4	3	23.08	14	7.00
Cadmium	214	21	9.81	0.2	5	0.2	24.9	4.2	0.6	7.1	5.1	5	23.81	0	0.00
Calcium	220	217	98.64	7	275,000	1,390	1,580,000	168,327	108,000	208,958	NA	NA	NA	NA	NA
Chromium	284	76	26.76	0.4	16.2	0.7	413	73.8	29.5	100	15.66	51	67.11	1	0.48
Chromium VI	171	39	22.81	10	54.1	8	493	121	63.0	133	NA	NA	NA	NA	NA
Cobalt	213	93	43.66	0.4	20	0.4	57	6.1	3.5	7.6	20.8	3	3.23	0	0.00
Copper	215	42	19.53	0.3	21.3	1.1	140	17.2	5.2	27.0	28.04	7	16.67	0	0.00
Iron	220	75	34.09	4.6	2,340	12	77,300	2,625	310	9,619	2,380	12	16.00	0	0.00
Iron (II)	7	0	0.00	50	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	213	19	8.92	0.008	14	1.6	26.1	9.7	8.0	8.2	14.44	7	36.84	0	0.00
Magnesium	220	216	98.18	12.8	194,000	1,940	2,100,000	371,082	216,500	392,877	1,440,000	6	2.78	0	0.00
Manganese	214	201	93.93	0.1	124	1.3	29,600	2,017	937	3,766	8,140	13	6.47	0	0.00
Mercury	212	12	5.66	0.04	0.4	0.10	1.10	0.32	0.19	0.33	0.6	2	16.67	0	0.00
Molybdenum	195	80	41.03	0.4	20	0.93	116.00	22.0	9.7	26.6	61.9	9	11.25	0	0.00
Nickel	275	152	55.27	0.7	91.1	1.1	317	39.4	24.5	44.7	96.48	18	11.84	0	0.00
Potassium	220	219	99.55	26.5	83,100	926	478,000	62,854	23,900	83,907	448,000	1	0.46	0	0.00
Selenium	207	27	13.04	2.0	34	2.3	22.6	4.8	3.6	4.0	14.5	1	3.70	11	6.11
Silver	212	13	6.13	0.4	8.9	0	3.3	1.6	1.6	0.9	7.43	0	0.00	1	0.50
Sodium	220	220	100.00	22.2	59,100	74,100	9,060,000	1,835,707	1,080,000	1,973,818	9,242,000	0	0.00	NA	NA
Thallium	197	33	16.75	0.008	88	0	50.7	6.381	3.000	9.286	12.97	3	9.09	14	8.54
Vanadium	210	130	61.90	0.4	44.1	0.63	179	11.8	5.65	22.5	26.62	9	6.92	1	1.25
Zinc	216	43	19.91	0.3	53.3	2.1	874	75.5	12.4	177	75.68	9	20.93	0	0.00

Notes:

µg/L Microgram per liter
HGAL Hunters Point groundwater ambient level
NA Not available

TABLE 2-15: PARCEL D VOLATILE ORGANIC COMPOUND DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
1,1,1,2-Tetrachloroethane	12	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	252	2	0.79	0.5	100	1.0	1	1.0	1.0	0
1,1,2,2-Tetrachloroethane	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-Trifluoroethane	79	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	252	1	0.40	0.5	100	1	1	1.0	1	NA
1,1-Dichloroethane	252	2	0.79	0.5	100	0.4	0.4	0	0	0
1,1-Dichloroethene	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	12	0	0.00	1	1	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	221	0	0.00	0.5	50	ND	ND	ND	ND	ND
1,2-Dibromo-3-Chloropropane	28	0	0.00	1	3	ND	ND	ND	ND	ND
1,2-Dibromoethane	36	0	0.00	1	3	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	243	1	0.41	0.5	50	0.5	0.50	0.50	0.50	NA
1,2-Dichloroethane	252	1	0.40	0.5	100	0.2	0.2	0.2	0.2	NA
1,2-Dichloroethene (Total)	177	11	6.21	0.5	100	0.3	5	3.1	3	1.6
1,2-Dichloropropane	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	243	0	0.00	0.5	50	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	243	1	0.41	0.5	50	0.3	0.3	0.3	0.3	NA
2-Butanone	174	0	0.00	0.5	100	ND	ND	ND	ND	ND
2-Chloroethyl Vinyl Ether	47	0	0.00	0.5	1	ND	ND	ND	ND	ND
2-Hexanone	139	1	0.72	4	100	0.6	0.6	0.6	0.6	NA
4-Methyl-2-Pentanone	172	1	0.58	0.5	100	0.9	0.9	0.9	0.9	NA
Acetone	173	2	1.16	0.5	100	9	71	40.0	40	31
Benzene	208	7	3.37	0.3	100	0.2	650	102	14	224
Bromobenzene	12	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Bromochloromethane	16	0	0.00	1	3	ND	ND	ND	ND	ND
Bromodichloromethane	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Bromoform	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Bromomethane	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Carbon Disulfide	173	4	2.31	0.5	100	0.4	3	1	0.8	1
Carbon Tetrachloride	252	4	1.59	0.5	100	0.3	0.9	0.5	0.3	0
Chlorobenzene	253	0	0.00	0.5	100	ND	ND	ND	ND	ND
Chloroethane	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Chloroform	252	40	15.87	0.5	100	0.1	21	2.8	1.5	3.8
Chloromethane	252	1	0.40	0.5	100	0.6	0.6	1	1	NA

TABLE 2-15: PARCEL D VOLATILE ORGANIC COMPOUND DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Cis-1,2-Dichloroethene	75	3	4.00	0.5	3	1	3	2	1.6	1
Cis-1,3-Dichloropropene	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Dibromochloromethane	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Dibromomethane	12	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Dichlorodifluoromethane	59	0	0.00	0.5	1	ND	ND	ND	ND	ND
Ethane	19	0	0.00	3	4	ND	ND	ND	ND	ND
Ethene	19	0	0.00	3	3	ND	ND	ND	ND	ND
Ethylbenzene	208	8	3.85	0.3	100	0.3	350	69.6	18.5	114
M,P-Xylenes	1	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Methane	20	9	45.00	0.9	3	3	1,600	502	408	644
Methylene Chloride	252	1	0.40	0.3	100	45	45	45.0	45	NA
O-Xylene	1	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Styrene	173	0	0.00	0.5	100	ND	ND	ND	ND	ND
Tert-Butyl Methyl Ether	32	4	12.50	0.5	5	0.0	2.0	0.8	0.5	0.7
Tetrachloroethene	252	8	3.17	0.5	100	0.2	25	10.9	10.6	7.9
Toluene	208	6	2.88	0.3	100	0.2	8.0	2.4	2.0	2.6
Trans-1,2-Dichloroethene	75	0	0.00	0.5	3	ND	ND	ND	ND	ND
Trans-1,3-Dichloropropene	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Trichloroethene	252	23	9.13	0.5	100	0.20	72	13.3	6.0	17.8
Trichlorofluoromethane	59	0	0.00	0.5	1	ND	ND	ND	ND	ND
Vinyl Acetate	26	0	0.00	10	10	ND	ND	ND	ND	ND
Vinyl Chloride	252	0	0.00	0.5	100	ND	ND	ND	ND	ND
Xylene (Total)	207	8	3.86	0.5	100	0.43	1200	203	40.5	386

Notes:

µg/L Microgram per liter

NA Not available

ND Nondetect

TABLE 2-16: PARCEL D SEMIVOLATILE ORGANIC COMPOUND DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Comparison of Detections: Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
1,4-Dioxane	1	0	0.00	1	1	ND	ND	ND	ND	ND
2,2'-Oxybis(1-Chloropropane)	193	0	0.00	10	50	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	183	0	0.00	25	250	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	183	0	0.00	10	100	ND	ND	ND	ND	ND
2,4-Dichlorophenol	183	0	0.00	10	100	ND	ND	ND	ND	ND
2,4-Dimethylphenol	183	1	0.55	10	100	4	4	4	4	NA
2,4-Dinitrophenol	179	0	0.00	25	250	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	193	0	0.00	10	50	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	193	0	0.00	10	50	ND	ND	ND	ND	ND
2-Chloronaphthalene	193	0	0.00	10	50	ND	ND	ND	ND	ND
2-Chlorophenol	184	0	0.00	10	100	ND	ND	ND	ND	ND
2-Methylnaphthalene	200	2	1.00	2	50	4	24	14	14	10
2-Methylphenol	183	0	0.00	10	100	ND	ND	ND	ND	ND
2-Nitroaniline	192	0	0.00	25	130	ND	ND	ND	ND	ND
2-Nitrophenol	184	0	0.00	10	100	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	189	0	0.00	10	50	ND	ND	ND	ND	ND
3-Nitroaniline	193	0	0.00	25	130	ND	ND	ND	ND	ND
4,6-Dinitro-2-Methylphenol	179	0	0.00	25	250	ND	ND	ND	ND	ND
4-Bromophenyl-Phenylether	193	0	0.00	10	50	ND	ND	ND	ND	ND
4-Chloro-3-Methylphenol	183	0	0.00	10	100	ND	ND	ND	ND	ND
4-Chloroaniline	193	0	0.00	10	50	ND	ND	ND	ND	ND
4-Chlorophenyl-Phenylether	193	0	0.00	10	50	ND	ND	ND	ND	ND
4-Methylphenol	183	1	0.55	10	100	2	2	2	2	NA
4-Nitroaniline	193	0	0.00	25	130	ND	ND	ND	ND	ND
4-Nitrophenol	184	0	0.00	25	250	ND	ND	ND	ND	ND
Acenaphthene	226	1	0.44	2	50	17	17	17	17	NA
Acenaphthylene	226	1	0.44	2	50	83	83	83	83	NA
Anthracene	226	1	0.44	0.7	50	2	2	2	2	NA
Benzo(a)Anthracene	226	0	0.00	0.08	50	ND	ND	ND	ND	ND
Benzo(a)Pyrene	223	4	1.79	0.05	100	0.06	0.30	0.17	0.15	0.09
Benzo(b)Fluoranthene	223	6	2.69	0.02	100	0.03	0.20	0.08	0.05	0.06
Benzo(g,h,i)Perylene	223	2	0.90	0.08	140	0.20	0.30	0.25	0.25	0.05

TABLE 2-16: PARCEL D SEMIVOLATILE ORGANIC COMPOUND DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (μg/L)	Maximum Detection Limit (μg/L)	Minimum Detection (μg/L)	Maximum Detection (μg/L)	Average of Detects (μg/L)	Median of Detects (μg/L)	Standard Deviation of Detects
Benzo(k)Fluoranthene	223	3	1.35	0.02	100	0.03	0.08	0.06	0.06	0.02
Benzoic Acid	13	0	0.00	50	50	ND	ND	ND	ND	ND
Benzyl Alcohol	12	0	0.00	10	10	ND	ND	ND	ND	ND
Bis(2-Chloroethoxy)Methane	193	0	0.00	10	50	ND	ND	ND	ND	ND
Bis(2-Chloroethyl)Ether	193	0	0.00	10	50	ND	ND	ND	ND	ND
Bis(2-Ethylhexyl)Phthalate	193	2	1.04	0.6	67	28	39	34	34	5.5
Butylbenzylphthalate	193	0	0.00	10	50	ND	ND	ND	ND	ND
Carbazole	180	0	0.00	10	50	ND	ND	ND	ND	ND
Chrysene	226	0	0.00	0.2	50	ND	ND	ND	ND	ND
Dibenz(a,h)Anthracene	223	0	0.00	0.2	100	ND	ND	ND	ND	ND
Dibenzofuran	193	0	0.00	10	50	ND	ND	ND	ND	ND
Diethylphthalate	193	0	0.00	10	50	ND	ND	ND	ND	ND
Dimethylphthalate	193	0	0.00	10	50	ND	ND	ND	ND	ND
Di-N-Butylphthalate	193	0	0.00	10	50	ND	ND	ND	ND	ND
Di-N-Octylphthalate	190	0	0.00	10	100	ND	ND	ND	ND	ND
Fluoranthene	226	1	0.44	0.2	50	0.2	0.2	0.2	0.2	NA
Fluorene	226	5	2.21	0.2	50	0.2	0.6	0.4	0.4	0.1
Hexachlorobenzene	193	0	0.00	10	50	ND	ND	ND	ND	ND
Hexachlorobutadiene	193	0	0.00	10	50	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	191	0	0.00	10	50	ND	ND	ND	ND	ND
Hexachloroethane	193	4	2.07	10	50	45	120	94	105	29
Indeno(1,2,3-cd)Pyrene	223	1	0.45	0.2	100	0.3	0.3	0.3	0.3	NA
Isophorone	193	0	0.00	10	50	ND	ND	ND	ND	ND
Naphthalene	226	2	0.88	2	50	8	58	33	33	25
Nitrobenzene	193	0	0.00	10	50	ND	ND	ND	ND	ND
N-Nitroso-Di-N-Propylamine	193	0	0.00	10	50	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	193	0	0.00	1	50	ND	ND	ND	ND	ND
Pentachlorophenol	183	0	0.00	25	250	ND	ND	ND	ND	ND
Phenanthrene	226	0	0.00	0.6	50	ND	ND	ND	ND	ND
Phenol	183	1	0.55	10	100	62	62	62	62	NA
Pyrene	226	1	0.44	0.3	50	0.3	0.3	0.3	0.3	NA
Total Chlordane	193	0	0.00	0	0	ND	ND	ND	ND	ND

TABLE 2-16: PARCEL D SEMIVOLATILE ORGANIC COMPOUND DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Total HMW PAH	226	6	2.65	0	0	1.2	141.4	25.6	2.8	51.8
Total LMW PAH	226	6	2.65	0	0	7.7	214	95.1	69.0	73.2
Total PAH	226	11	4.87	0	0	8.7	694	138	40.7	197.8

Notes:

µg/L	Microgram per liter
HMW	High molecular weight
LMW	Low molecular weight
NA	Not available
ND	Nondetect
PAH	Polynuclear aromatic hydrocarbon

TABLE 2-17: PARCEL D PESTICIDES, PCBS, AND CYANIDE DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
4,4'-DDD	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
4,4'-DDE	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
4,4'-DDT	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
DDT (Total)	138	0	0.00	0	0	ND	ND	ND	ND	ND
Aldrin	138	0	0.00	0.05	0.05	ND	ND	ND	ND	ND
alpha-BHC	138	0	0.00	0.05	0.05	ND	ND	ND	ND	ND
alpha-Chlordane	138	0	0.00	0.05	0.5	ND	ND	ND	ND	ND
gamma-Chlordane (Lindane	138	0	0.00	0.05	0.5	ND	ND	ND	ND	ND
Chlordane (Total)	138	0	0.00	0	0	ND	ND	ND	ND	ND
Aroclor-1016	141	0	0.00	0.5	1	ND	ND	ND	ND	ND
Aroclor-1221	141	0	0.00	0.5	2	ND	ND	ND	ND	ND
Aroclor-1232	141	0	0.00	0.5	1	ND	ND	ND	ND	ND
Aroclor-1242	141	0	0.00	0.5	1	ND	ND	ND	ND	ND
Aroclor-1248	141	0	0.00	0.5	1	ND	ND	ND	ND	ND
Aroclor-1254	141	0	0.00	0.5	1	ND	ND	ND	ND	ND
Aroclor-1260	141	0	0.00	0.5	1	ND	ND	ND	ND	ND
Aroclor (Total)	141	0	0.00	0	0	ND	ND	ND	ND	ND
beta-BHC	138	0	0.00	0.05	0.05	ND	ND	ND	ND	ND
Cyanide	103	8	7.77	0.4	10	0.08	12	4	2	5
delta-BHC	138	0	0.00	0.05	0.05	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	138	0	0.00	0.05	0.05	ND	ND	ND	ND	ND
Dieldrin	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
Endosulfan I	138	0	0.00	0.05	0.05	ND	ND	ND	ND	ND
Endosulfan II	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
Endosulfan Sulfate	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
Endrin	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
Endrin Aldehyde	130	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
Endrin Ketone	138	0	0.00	0.1	0.1	ND	ND	ND	ND	ND
Heptachlor	138	0	0.00	0.05	0.05	ND	ND	ND	ND	ND

Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Comparison of Detections						
				Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Heptachlor Epoxide	137	0	0.00	0.01	0.05	ND	ND	ND	ND	ND
Methoxychlor	138	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Toxaphene	138	0	0.00	1	5	ND	ND	ND	ND	ND

Notes:

µg/L	Microgram per liter
BHC	Benzene hexachloride
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
NA	Not available
ND	Nondetect
PCB	Polychlorinated biphenyl

TABLE 2-18: PARCEL D DIOXINS AND FURANS DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections							
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
1,2,3,4,6,7,8,9-OCDD	19	0	0.00	0.0006	0.007	ND	ND	ND	ND	ND
1,2,3,4,6,7,8,9-OCDF	19	0	0.00	0.0006	0.01	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-HPCDD	19	0	0.00	0.00009	0.001	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-HPCDF	19	0	0.00	0.0001	0.001	ND	ND	ND	ND	ND
1,2,3,4,7,8,9-HPCDF	19	0	0.00	0.0001	0.001	ND	ND	ND	ND	ND
1,2,3,4,7,8-HXCDD	19	0	0.00	0.0001	0.0007	ND	ND	ND	ND	ND
1,2,3,4,7,8-HXCDF	19	0	0.00	0.00007	0.0009	ND	ND	ND	ND	ND
1,2,3,6,7,8-HXCDD	6	0	0.00	0.0001	0.0004	ND	ND	ND	ND	ND
1,2,3,7,8,9-HXCDD	19	0	0.00	0.0001	0.0007	ND	ND	ND	ND	ND
1,2,3,7,8,9-HXCDF	19	0	0.00	0.00007	0.0009	ND	ND	ND	ND	ND
1,2,3,7,8-PECDD	19	0	0.00	0.00009	0.0006	ND	ND	ND	ND	ND
1,2,3,7,8-PECDF	6	0	0.00	0.00002	0.001	ND	ND	ND	ND	ND
1,2,4,6,7,8-HXCDF	6	0	0.00	0.00007	0.0009	ND	ND	ND	ND	ND
2,3,4,6,7,8-HXCDF	19	0	0.00	0.00007	0.0009	ND	ND	ND	ND	ND
2,3,4,7,8-PECDF	6	0	0.00	0.00002	0.001	ND	ND	ND	ND	ND
2,3,7,8-TCDD	19	0	0.00	0.00002	0.0001	ND	ND	ND	ND	ND
2,3,7,8-TCDF	19	0	0.00	0.00004	0.002	ND	ND	ND	ND	ND
Dibenzofuran	11	3	27.27	0.001	0.015	0.01	0.01	0.01	0.01	0.002
Total HPCDD	19	0	0.00	0.00009	0.001	ND	ND	ND	ND	ND
Total HPCDF	19	0	0.00	0.0001	0.001	ND	ND	ND	ND	ND
Total HXCDD	19	0	0.00	0.0001	0.0007	ND	ND	ND	ND	ND
Total HXCDF	19	0	0.00	0.00007	0.0009	ND	ND	ND	ND	ND
Total PECDD	19	0	0.00	0.00009	0.0006	ND	ND	ND	ND	ND
Total PECDF	19	0	0.00	0.00002	0.001	ND	ND	ND	ND	ND
Total TCDD	19	0	0.00	0.00002	0.0001	ND	ND	ND	ND	ND
Total TCDF	19	1	5.26	0.00004	0.001	0.004	0.004	0.004	0.004	NA

Notes:

μg/L	Microgram per liter
HPCDD	Heptachlorodibenzodioxin
HPCDF	Heptachlorodibenzofuran
HXCDD	Hexachlorodibenzodioxin
HXCDF	Hexachlorodibenzofuran
ND	Not detected
OCDD	Octachlorodibenzodioxin
OCDF	Octachlorodibenzofuran
PECDD	Pentachlorodibenzodioxin
PECDF	Pentachlorodibenzofuran
TCDD	Tetrachlorodibenzodioxin
TCDF	Tetrachlorodibenzofuran

TABLE 2-19: PARCEL D RADIONUCLIDE DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Actinum-228	8	0	0.00	14	25	ND	ND	ND	ND	ND
Aluminum-26	8	0	0.00	4.1	7	ND	ND	ND	ND	ND
Americium-241	8	1	12.50	0.014	30	0.018	0.018	0.0	0.0	NA
Antimony-124	8	0	0.00	3.2	5	ND	ND	ND	ND	ND
Antimony-125	8	1	12.50	7.7	10	11.3	11.3	11.3	11.3	NA
Beryllium-7	8	0	0.00	25	38	ND	ND	ND	ND	ND
Bismuth-212	8	0	0.00	43	65	ND	ND	ND	ND	ND
Bismuth-214	8	0	0.00	9.7	14	ND	ND	ND	ND	ND
Cadmium-109	8	0	0.00	74	130	ND	ND	ND	ND	ND
Cerium-139	8	0	0.00	2.8	3.2	ND	ND	ND	ND	ND
Cerium-144	8	0	0.00	17	21	ND	ND	ND	ND	ND
Cesium-134	8	0	0.00	3.1	5.5	ND	ND	ND	ND	ND
Cesium-137	8	0	0.00	2.9	4.2	ND	ND	ND	ND	ND
Chromium-51	8	0	0.00	28	47	ND	ND	ND	ND	ND
Cobalt-56	8	0	0.00	5.8	9.1	ND	ND	ND	ND	ND
Cobalt-57	8	0	0.00	2.3	2.8	ND	ND	ND	ND	ND
Cobalt-58	8	0	0.00	3.3	5.1	ND	ND	ND	ND	ND
Cobalt-60	8	0	0.00	3.4	5.8	ND	ND	ND	ND	ND
Europium-152	8	0	0.00	15	28	ND	ND	ND	ND	ND
Europium-154	8	0	0.00	16	25	ND	ND	ND	ND	ND
Europium-155	8	0	0.00	9.3	13	ND	ND	ND	ND	ND
Iodine-131	8	0	0.00	6.4	18	ND	ND	ND	ND	ND
Iron-59	8	0	0.00	7.9	11	ND	ND	ND	ND	ND
Lead-212	8	0	0.00	7.3	8.7	ND	ND	ND	ND	ND
Lead-214	8	0	0.00	6.4	11	ND	ND	ND	ND	ND
Manganese-54	8	0	0.00	3.4	4.5	ND	ND	ND	ND	ND
Niobium-94	8	0	0.00	2.8	4.2	ND	ND	ND	ND	ND
Niobium-95	8	0	0.00	3.1	4.8	ND	ND	ND	ND	ND

TABLE 2-19: PARCEL D RADIONUCLIDE DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Potassium-40	8	0	0.00	55	94	ND	ND	ND	ND	ND
Protactinum-234m	8	0	0.00	530	800	ND	ND	ND	ND	ND
Radium-226	8	1	12.50	0.2	0.55	0.18	0.18	0.18	0.18	NA
Radium-228	8	5	62.50	0.66	0.77	0.7	1.1	0.85	0.81	0.14
Ruthenium-106	8	0	0.00	29	39	ND	ND	ND	ND	ND
Scandium-46	8	0	0.00	3.4	4.9	ND	ND	ND	ND	ND
Silver-110m	8	0	0.00	2.7	4.2	ND	ND	ND	ND	ND
Sodium-22	8	0	0.00	3.2	5.4	ND	ND	ND	ND	ND
Strontium-90	8	0	0.00	0.51	0.81	ND	ND	ND	ND	ND
Thallium-208	8	0	0.00	3.1	5.3	ND	ND	ND	ND	ND
Thorium-227	8	0	0.00	17	29	ND	ND	ND	ND	ND
Thorium-234	8	0	0.00	74	84	ND	ND	ND	ND	ND
Tritium	8	0	0.00	350	380	ND	ND	ND	ND	ND
Uranium-234	8	4	50.00	0.036	0.08	0.212	1.8	0.979	0.951	0.758
Uranium-235	8	0	0.00	0.018	23	ND	ND	ND	ND	ND
Uranium-238	8	8	100.00	0.012	0.058	0.052	1.27	0.4	0.094	0.479
Zinc-65	8	0	0.00	7.1	11	ND	ND	ND	ND	ND

Notes:

µg/L Microgram per liter
NA Not available
ND Nondetect

TABLE 2-20: PARCEL D TOTAL PETROLEUM HYDROCARBONS DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Comparison of Detections						
				Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Diesel-Range Organics	205	26	12.68	50	500	51	1700	205	85	344
Gasoline-Range Organics	216	24	11.11	0.05	5,000	26	20000	1335	37	4264
Motor Oil-Range Organics	155	75	48.39	100	1,000	54	2,000	253	140	303
Total Oil & Grease	20	3	15.00	5	5,000	6,000	10,000	8,000	8,000	1,633
TPH-JP5 (Aviation Fuel)	4	0	0.00	500	500	ND	ND	ND	ND	ND
TPH-Kerosene	5	0	0.00	50	500	ND	ND	ND	ND	ND
TRPH	118	5	4.24	400	1,000	500	3,000	1,120	600	957.9144
TPH-Extractable Hydrocarbon	19	0	0.00	50	500	ND	ND	ND	ND	ND
TPH-Purgeable Hydrocarbon	20	0	0	0.5	500	ND	ND	ND	ND	ND

Notes:

µg/L	Microgram per liter
NA	Not available
ND	Nondetect
TPH	Total petroleum hydrocarbons
TRPH	Total recoverable petroleum hydrocarbons

TABLE 2-21: PARCEL D WATER QUALITY CHARACTERISTICS DATA SUMMARY TABLE, A-AQUIFER GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Analyte	Units	Number Analyzed	Number Detected	Percent Detected (%)	Comparison of Detections: Minimum Detection Limit	Maximum Detection Limit	Minimum Detection	Maximum Detection	Average of Detects	Median of Detects	Standard Deviation of Detects
Chloride	µg/L	101	101	100.00	200	1,000,000	31,400	15,900,000	3,162,435	1,330,000	4,064,852
Ethane	µg/L	19	0	0.00	3	4	ND	ND	ND	ND	ND
Ethene	µg/L	19	0	0.00	3	3	ND	ND	ND	ND	ND
Fluoride	µg/L	31	21	67.74	100	5,000	100	1,060	338	240	253
Hydrogen Sulfide	µg/L	8	0	0.00	200	200	ND	ND	ND	ND	ND
Methane	µg/L	20	9	45.00	1	3	3	1,600	502	408	644
Nitrate as Nitrogen	µg/L	92	44	47.83	10	5,000	30	65,000	4,411	1,150	10,726
Nitrate/Nitrite as Nitrogen	µg/L	22	20	90.91	10	10	20	24,400	2,913	1,500	5,184
Nitrite as Nitrogen	µg/L	61	5	8.20	5	150,000	5	9,100	2,001	44	3,564
Orthophosphate	µg/L	79	11	13.92	50	20,000	250	13,100	2,250	690	3,649
Sulfate	µg/L	101	101	100.00	50	250,000	6,400	2,290,000	459,264	237,000	515,316
Carbon Dioxide in Water	µg/L	5	4	80.00	3,000	3,000	22,000	360,000	129,250	67,500	134,617
Dissolved Oxygen	µg/L	70	70	100.00	NA	NA	100	8230	2,941	2,320	2,232
Downhole Dissolved Oxyten Bottom	µg/L	31	31	100.00	NA	NA	200	5620	1,762	1,000	1,537
Downhole Dissolved Oxygen Middle	µg/L	25	25	100.00	NA	NA	260	6400	2,204	1,370	1,680
Downhole Dissolved Oxygen Top	µg/L	35	35	100.00	NA	NA	550	9000	2,804	1,760	2,229
Hydrogen in Water	µg/L	5	0	0.00	200	200	ND	ND	ND	ND	ND
Bicarbonate Alkalinity	µg/L	14	14	100.00	1,000	1,000	54,000	504,000	278,286	257,000	133,069
Carbonate Alkalinity	µg/L	14	1	7.14	1,000	1,000	176,000	176,000	176,000	176,000	NA
Hydroxide Alkalinity	µg/L	14	0	0.00	1,000	1,000	ND	ND	ND	ND	ND
Total Alkalinity	µg/L	14	14	100.00	1,000	1,000	108,000	504,000	290,500	257,000	119,029
Salinity	%	28	28	100.00	NA	NA	0.03	12.10	2.00	0.69	3.3
Salinity	µg/L	48	45	93.75	2	5	0.40	56.20	8.30	5.30	9.1
Total Dissolved Solids	µg/L	161	159	98.76	4,000	1,000,000	7,500	29,500,000	7,061,355	3,860,000	7,373,528
Total Dissolved Solids	µg/L	28	13	46.43	5,000	10,000	2,000	318,000	30,769	7,000	83,011
Total Organic Carbon	µg/L	8	8	100.00	500	500	1,900	23,600	5,700	3,100	6,849
Specific Conductance	µs/cm	73	73	100.00	NA	NA	0.032	56.6	12.7	10.7	12.4
Temperature	C	74	74	100.00	NA	NA	13.15	24.21	18.30	18.22	2.32
Oxidation-Reduction Potential	mV	46	46	100.00	NA	NA	-311.8	309.5	58.6	35.3	151
pH	pH	230	230	100.00	0	0.1	6.12	11.8	7.4	7.3	0.7
Turbidity	NTU	68	68	100.00	NA	NA	0	1118	115	13	253
Fecal Coliform	cfu/100mL	9	1	12.50	2	2	2	2	2	2	NA
Fecal Coliform	cfu/100mL	1	0	0.00	4	4	ND	ND	ND	ND	ND
Fecal Coliform	mpn/100mL	8	1	12.50	2	2	2	2	2	2	NA

Notes:

µs/cm	Microsiemens per centimeter	NA	Not available
µg/L	Microgram per liter	ND	Nondetect
cfu/100mL	Coliform units per 100 milliliters	NTU	Nephelometric turbidity unit

TABLE 2-22: PARCEL D METALS DATA SUMMARY TABLE, B-AQUIFER GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections							Comparison of HGALs				
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects	A-aquifer HGAL Screening Level	Number of Detects Exceeding HGAL	Percent of Detects Exceeding HGAL	Number of Nondetects with Limits Exceeding HGAL	Percent of Nondetects with Limits Exceeding HGAL
Aluminum	2	0	0.00	13.6	13.6	ND	ND	ND	ND	ND	NA	NA	ND	NA	NA
Antimony	2	0	0.00	4.3	4.3	ND	ND	ND	ND	ND	43.26	ND	ND	0	0.00
Arsenic	2	0	0.00	4.6	4.6	ND	ND	ND	ND	ND	27.34	ND	ND	0	0.00
Barium	2	2	100.00	6.9	6.9	68.2	68.9	68.55	68.55	0.35	504.2	0	0.00	NA	All Detected
Beryllium	2	0	0.00	0.2	0.2	ND	ND	ND	ND	ND	1.4	ND	ND	0	0.00
Cadmium	2	0	0.00	0.4	0.4	ND	ND	ND	ND	ND	5.08	ND	ND	0	0.00
Calcium	3	3	100.00	141	164	18,900	28,200	24,633	26,800	4,094	NA	NA	NA	NA	All Detected
Chromium	4	2	50.00	0.5	1.1	4	4.4	4.2	4.2	0.2	15.66	0	0.00	0	0.00
Chromium VI	4	0	0.00	10	10	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA
Cobalt	2	0	0.00	2.1	2.1	ND	ND	ND	ND	ND	20.8	ND	ND	0	0.00
Copper	2	0	0.00	2.5	3.7	ND	ND	ND	ND	ND	28.04	ND	ND	0	0.00
Iron	3	0	0.00	26.1	234	ND	ND	ND	ND	ND	2,380	ND	ND	0	0.00
Iron (II)	1	1	100.00	NA	NA	0	0	0	0	NA	NA	NA	NA	NA	NA
Lead	3	0	0.00	1.3	1.7	ND	ND	ND	ND	ND	14.44	ND	ND	0	0.00
Magnesium	3	3	100.00	127	348	32,000	46,200	39,833	41,300	5,889	1,440,000	0	0.00	NA	All Detected
Manganese	2	2	100.00	0.5	0.5	44.7	175	109.85	109.85	65.15	8,140	0	0.00	NA	All Detected
Manganese (II)	1	1	100.00	NA	NA	100	100	100	100	NA	NA	NA	NA	NA	NA
Mercury	2	0	0.00	0.1	0.1	ND	ND	ND	ND	ND	0.6	ND	ND	0	0.00
Molybdenum	2	1	50.00	3	3	8	8	8	8	NA	61.9	0	0.00	0	0.00
Nickel	4	2	50.00	1.7	2.1	2.4	4.6	3.5	3.5	1.1	96.48	0	0.00	0	0.00
Potassium	3	3	100.00	240	587	2,970	8,070	4,683	3,010	2,395	448,000	0	0.00	NA	All Detected
Selenium	2	2	100.00	2.7	2.7	2.7	3	2.85	2.85	0.15	14.5	0	0.00	NA	All Detected
Silver	2	0	0.00	1.9	1.9	ND	ND	ND	ND	ND	7.43	ND	ND	0	0.00
Sodium	3	3	100.00	1,940	5,900	108,000	332,000	184,333	113,000	104,436	9,242,000	0	0.00	NA	All Detected
Thallium	2	0	0.00	3.8	3.8	ND	ND	ND	ND	ND	12.97	ND	ND	0	0.00
Vanadium	2	2	100.00	2.2	2.2	9.1	14.5	11.8	11.8	2.7	26.62	0	0.00	NA	All Detected
Zinc	3	2	66.67	1.4	18.2	2.9	311	156.95	156.95	154.05	75.68	1	50.00	0	0.00

Notes:

µg/L Microgram per liter
HGAL Hunters Point groundwater ambient level
NA Not available

TABLE 2-23: PARCEL D VOLATILE ORGANIC COMPOUND DATA SUMMARY TABLE, B-AQUIFER GROUNDWATER

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

						Comparison of Detections				
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
1,1,1,2-Tetrachloroethane	1	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-Trifluoroethane	1	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,1-Dichloroethane	3	0	0.00	1	1	ND	ND	ND	ND	ND
1,1-Dichloroethene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	1	0	0.00	1	1	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,2-Dibromo-3-Chloropropane	3	0	0.00	1	2	ND	ND	ND	ND	ND
1,2-Dibromoethane	2	0	0.00	1	1	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,2-Dichloroethane	3	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
1,2-Dichloropropane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
2-Butanone	2	0	0.00	5	5	ND	ND	ND	ND	ND
2-Hexanone	2	0	0.00	5	5	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	2	0	0.00	5	5	ND	ND	ND	ND	ND
Acetone	2	1	50.00	5	5	51	51	51	51	NA
Benzene	3	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Bromobenzene	1	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Bromochloromethane	2	0	0.00	1	1	ND	ND	ND	ND	ND
Bromodichloromethane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Bromoform	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Bromomethane	3	0	0.00	1	1	ND	ND	ND	ND	ND
Carbon Disulfide	2	1	50.00	1	1	2	2	2	2	NA
Carbon Tetrachloride	3	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Chlorobenzene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND

TABLE 2-23: PARCEL D VOLATILE ORGANIC COMPOUND DATA SUMMARY TABLE, B-AQUIFER GROUNDWATER (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Chloroethane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Chloroform	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Chloromethane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Dibromochloromethane	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Dibromomethane	1	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Dichlorodifluoromethane	1	0	0.00	1	1	ND	ND	ND	ND	ND
Ethylbenzene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Methylene Chloride	3	0	0.00	2	5	ND	ND	ND	ND	ND
Styrene	2	0	0.00	1	1	ND	ND	ND	ND	ND
Tert-Butyl Methyl Ether	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Tetrachloroethene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Toluene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	3	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Trichloroethene	3	0	0.00	0.5	1	ND	ND	ND	ND	ND
Trichlorofluoromethane	1	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Vinyl Chloride	3	0	0.00	0.5	0.5	ND	ND	ND	ND	ND
Xylene (Total)	3	1	33.33	0.5	1	0.9	0.9	0.9	0.9	NA

Notes:

µg/L Microgram per liter
NA Not available
ND Nondetect

TABLE 2-24: PARCEL D WATER QUALITY CHARACTERISTIC DATA SUMMARY TABLE, B-AQUIFER GROUNDWATER

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

				Comparison of Detections						
Analyte	Number Analyzed	Number Detected	Percent Detected (%)	Minimum Detection Limit (µg/L)	Maximum Detection Limit (µg/L)	Minimum Detection (µg/L)	Maximum Detection (µg/L)	Average of Detects (µg/L)	Median of Detects (µg/L)	Standard Deviation of Detects
Chloride	1	1	100.00	200	200	166,000	166,000	166,000	166,000	NA
Ethane	1	0	0.00	4	4	ND	ND	ND	ND	ND
Ethene	1	0	0.00	3	3	ND	ND	ND	ND	ND
Methane	1	1	100.00	2	2	11	11	11	11	NA
Nitrate as Nitrogen	1	0	0.00	10	10	ND	ND	ND	ND	ND
Nitrate/Nitrate as Nitrogen	1	0	0.00	10	10	ND	ND	ND	ND	ND
Nitrite as Nitrogen	1	0	0.00	5	5	ND	ND	ND	ND	ND
Sulfate	1	1	100.00	200	200	4,600	4,600	4,600	4,600	NA
Dissolved Oxygen	6	6	100.00	NA	NA	260	2,920	1,728	1,795	1,020
Downhole Dissolved Oxygen Bottom	3	3	100.00	NA	NA	520	680	580	540	71
Downhole Dissolved Oxygen Middle	3	3	100.00	NA	NA	580	860	683	610	126
Downhole Dissolved Oxygen Top	3	3	100.00	NA	NA	780	2,560	1,513	1,200	760
Bicarbonate Alkalinity	1	1	100.00	1,000	1,000	248,000	248,000	248,000	248,000	NA
Carbonate Alkalinity	1	0	0.00	1,000	1,000	ND	ND	ND	ND	ND
Hydroxide Alkalinity	1	0	0.00	1,000	1,000	ND	ND	ND	ND	ND
Total Alkalinity	1	1	100.00	1,000	1,000	248,000	248,000	248,000	248,000	NA
Salinity	6	6	100.00	NA	NA	0.02	0.5	0.3	0.3	0.09
Total Dissolved Solids	6	6	100.00	5,000	5,000	280,000	860,000	443,833	350,000	198,612
Specific Conductance	6	6	100.00	NA	NA	0.585	1.69	0.872	0.695	0.389
Temperature	6	6	100.00	NA	NA	16.6	19.0	18.0	18.2	0.83
Oxidation-Reduction Potential	3	3	100.00	NA	NA	-53.6	125.7	51	81	76
pH	5	5	100.00	NA	NA	7.45	7.87	7.68	7.72	0.14
Turbidity	5	5	100.00	NA	NA	0	1.9	0.5	0	0.74

Notes:

µg/L Microgram per liter

NA Not available

ND Nondetect

3.0 RISK EVALUATION SUMMARY AND REMEDIATION GOALS

This section summarizes the potential human health and environmental risks from exposure to chemicals present in soil and groundwater at Parcel D, identifies COCs for human health and environmental endpoints, and presents remediation goals for the identified COCs. The nature and extent of contamination of soil and groundwater at Parcel D is presented in Section 2.0.

3.1 HUMAN HEALTH RISK ASSESSMENT

A revised baseline HHRA was conducted for Parcel D. The objectives of the revised HHRA were to:

- Estimate the potential human health risks associated with potential future land use scenarios
- Identify the environmental media and contaminants that pose the primary health concerns
- Identify the environmental media and contaminants that are likely to pose little or no threat to human health
- Provide a foundation for assessing the need for further response actions

The original HHRA for Parcel D was conducted in 1996 as part of the RI for Parcel D (PRC, LFR, and U&A 1996). Since the RI was completed, additional data were collected at Parcel D during the TCRA in 2000 and 2001(Tetra Tech and IT Corp. 2001). Tetra Tech revised the original HHRA in 2002 as part of the draft revised FS to supplement the original HHRA with the soil data collected during the 2000 and 2001 TCRA. An additional TCRA in 2004 resulted in additional soil excavation and soil data collection (Tetra Tech and ITSI 2005). The HHRA presented in this FS report revises the HHRA presented in the 2002 draft revised FS report to account for the soil data collected during the 2004 TCRA and to incorporate changes in regulatory guidance and toxicological criteria that have occurred since the original HHRA was prepared in 1996. Soil data associated with sampling locations excavated and removed from HPS during the 2000, 2001, and 2004 TCRAs, as well as non-TCRAs for HPS, are excluded from this HHRA. Data for soil associated with sampling locations that have not been removed, including unremoved confirmation samples collected after removal actions, are included in the HHRA. In addition, groundwater data collected since the 2002 HHRA through quarter 18 (June 2004) as part of the basewide groundwater monitoring program for HPS are included in this HHRA. Lastly, the HHRA was revised based on HPS BCT agreements during 2003 and 2004.

The HHRA calculated cancer risks and noncancer hazards from exposure to chemicals of potential concern (COPC) in all affected environmental media for each pathway identified as potentially complete. Appendix B details the HHRA methodology and results for evaluating the COPC and assessing the COCs. This section provides an overview of the exposure scenarios and pathways evaluated in the HHRA and summarizes the results. In addition, remediation goals are presented for the COCs for Parcel D, as identified from the results of the HHRA.

3.1.1 Exposure Scenarios and Pathways

The Redevelopment Plan outlines the planned reuses for Parcel D (San Francisco Redevelopment Agency 1997). To help identify the areas of Parcel D associated with specific planned reuses, Parcel D was divided into redevelopment blocks. Each redevelopment block was then assigned a redevelopment block number. Figure 3-1 shows the locations of each of the redevelopment blocks assigned to Parcel D, the associated redevelopment block number, and the specific planned reuse for each redevelopment block. According to the Redevelopment Plan, most of the planned reuse for Parcel D is industrial (San Francisco Redevelopment Agency 1997). Other planned reuses of Parcel D include open space and mixed use—that is, reuse that consists of both residential and industrial use (San Francisco Redevelopment Agency 1997). Evaluation of the recently proposed football stadium plan at Parcel D was not part of the scope of this document. However, information provided in this FS is relevant to a stadium reuse plan. The HHRA includes scenarios for alternative reuse, including industrial reuse and recreational reuse for the entire parcel. The industrial reuse scenario is conservative for the areas of the stadium complex that are regularly occupied, and the recreational scenario is appropriate for the remainder.

The table below summarizes the planned reuses for each redevelopment block at Parcel D.

Redevelopment Block	Planned Reuse	Associated Exposure Scenario for HHRA
DMI-1	Maritime Industrial	Industrial
30B	Industrial	
37	Industrial	
38	Industrial	
42	Industrial	
29	Educational/Cultural	
DOS-1	Open Space	Recreational
39	Open Space	
A	Research and Development	Residential
30A	Mixed Use	

Based on the planned reuses for Parcel D, and the likelihood that excavation and trenching activities will be required to develop Parcel D for the planned reuses, the following receptors were selected for evaluation in the HHRA for Parcel D:

- Resident (adult and child)
- Industrial worker (adult)
- Recreational user (adult and child)
- Construction worker (adult)

Table 3-1 presents an exposure matrix that summarizes the exposure pathways identified as potentially complete for each of these receptors. Both direct exposure pathways (for example, ingestion) and indirect exposure pathways (for example, ingestion of home-grown produce) were identified as potentially complete (see Table 3-1).

For purposes of the HHRA, each redevelopment block at Parcel D was divided into 0.5-acre exposure areas (approximately 150 feet by 150 feet) and 2,500-square foot exposure areas. The 0.5-acre exposure area size was selected by the HPS BCT and City and County of San Francisco as a reasonable estimate for a light industrial lot in the Bay area. The 2,500-square foot exposure area was selected by the BCT as a reasonable estimate for a residential lot because it is a minimum residential lot size for a single-family home allowed by the San Francisco planning code (City and County of San Francisco 1995). This HHRA refers to each 0.5-acre exposure area at Parcel D as an "industrial grid" and each 2,500-square foot exposure area as a "residential grid." For purposes of the HHRA, each grid was assigned a unique identification number, referred to as the "grid number."

Risks from exposure to soil were evaluated for each grid for which soil sampling data was collected and where the sampling locations have not been subject to removal actions. Grids with no soil sampling data were not sampled because no environmental releases are suspected in these areas. Residential grids were used to assess residential exposures, while industrial grids were used to assess industrial, recreational, and construction worker exposures.

Risks from exposure to COPCs in groundwater were assessed for the A- and B-aquifers. For the A-aquifer, residential and industrial exposure to groundwater from inhalation of volatile COPCs in groundwater that migrates through the subsurface to indoor air (vapor intrusion) is the only complete exposure pathway for the planned reuses of Parcel D. For the construction worker scenario, exposure to groundwater in the A-aquifer may occur during trenching activities. Residential exposure to groundwater in the A-aquifer from domestic use (such as ingestion) was not evaluated in the HHRA because the A-aquifer at HPS is not considered a potential source of drinking water (see Section 2.2.9). However, because groundwater in the B-aquifer is considered to be a low potential source of drinking water, residential exposure to groundwater was evaluated for the B-aquifer.

Risks from residential, industrial, and construction worker exposure to COPCs in the groundwater in the A-aquifer were assessed for three risk plume-based exposure areas: the IR-09 risk plume, the IR-33 risk plume, and the IR-71 risk plume. These risk plumes are present in the A-aquifer only. The risk plumes were developed using a specific methodology developed for the HHRA based on agreements made with the BCT (see Attachment B4, Figures B4-1 and B4-2). The risk plumes are based on historical as well as more recent data, incorporating the 12 most recent sampling results for each analyte at each well. Groundwater data collected at Parcel D through June 2004 were used to delineate these risk plumes. Because this methodology includes historical data over 10 years old, the risk plumes reflect a worst-case scenario of groundwater contamination. Current conditions differ from the risk plumes (see Figures 2-29 and 2-30). The IR-33 and IR-71 risk plumes are based on delineation of VOC concentrations to respective laboratory reporting limits. The IR-71 risk plume is based on delineation of chromium VI concentrations to the laboratory reporting limit for chromium VI. Chemical concentrations measured from some groundwater monitoring locations at Parcel D were not associated with risk plumes; these nonplume-based locations were evaluated on a grid-basis, using the same grid system that was used in the HHRA to evaluate soil exposures. This methodology serves as an efficient mechanism to locate each nonplume exposure area, and is consistent with the grid-based approach used to locate and evaluate soil exposures.

Although risk plumes are not present in the B-aquifer at Parcel D, for purposes of assessing the HHRA COPCs, plume boundaries delineated for the A-aquifer were extrapolated vertically and applied to the B-aquifer; the extrapolated plume boundaries were used to represent exposure areas for the B-aquifer for the residential domestic use evaluation. Similar to the approach used for the A-aquifer, chemical concentrations measured from groundwater monitoring locations in the B-aquifer at Parcel D that fell outside of the extrapolated plume boundaries were evaluated as nonplume exposure areas, using the exposure area grids established for soil.

For each redevelopment block, risks from exposure to COPCs in soil and groundwater were evaluated both for the specific exposure scenario associated with the planned reuse of the redevelopment block, and for the other potential exposure scenarios identified for Parcel D, regardless of the planned reuse of the redevelopment block. Using this approach, for each redevelopment block, risks were evaluated for residential, industrial, recreational, and construction worker exposures. The HHRA results summarized in this section are for the specific planned reuse of each redevelopment block. For groundwater in the B-aquifer, which was evaluated for residential exposure from domestic use, HHRA results are based on each exposure area evaluated, regardless of planned reuse. Risks associated with construction worker exposure at each redevelopment block are also summarized in this section, as exposures under this scenario may potentially occur, regardless of the planned reuse of the redevelopment block. Appendix B contains the risks results for all exposure scenarios evaluated for each redevelopment block.

3.1.2 Total and Incremental Risks for Soil Exposure

Both total and incremental risks were evaluated for exposure to soil at Parcel D. For the total risk evaluation, all detected chemicals were included as COPCs regardless of concentration, except for the essential nutrients calcium, magnesium, potassium, and sodium. The total risk evaluation provides an estimate of the risks posed by all chemicals at the site, including those present at concentrations at or below ambient levels. For the incremental risk evaluation, the above essential nutrients and metals with maximum measured concentrations below HPALs were excluded as COPCs. The incremental risk evaluation provides an estimate of risks posed by all chemicals at the site, except those that do not exceed ambient levels.

3.1.3 Soil Risk Summary

This section summarizes the results of the total and incremental risk evaluations for soil, based on planned reuse.

3.1.3.1 Total Risk Evaluation

For the total risk evaluation, risks from exposure to COPCs in soil were assessed for both surface soil (0 to 2 feet bgs) and subsurface soil (0 to 10 feet bgs). Figures 3-2 and 3-3 summarize the grid-specific total risk results for surface and subsurface soil, respectively, based on the planned reuse of the redevelopment block associated with each grid. Figure 3-4 summarizes the grid-specific total risk results for construction worker exposure to soil. The results for each grid are shown relative to the cancer risk threshold of 1×10^{-6}, highest segregated noncancer HI threshold of 1.0, and HPS RBC for lead (155 mg/kg for residential and recreational receptors, and 800 mg/kg for industrial and construction worker receptors). The specific calculated total cancer risk and noncancer HI results for each grid are listed in Tables 3-2, 3-3, and 3-4.

The risk results shown in the above referenced figures and tables represent total risk; that is, all detected chemicals not considered essential human nutrients were included in the risk evaluation. The total risk for most exposure areas exceeds the cancer risk threshold of 1×10^{-6}. For exposure areas planned for residential reuse, the total HI for all areas for which data are available (one exposure area for surface soil; three exposure areas for subsurface soil) also exceeds the threshold HI of 1.0.

Tables 3-5, 3-6, and 3-7 present a risk characterization analysis for those grids for which the total cancer risk exceeds 1×10^{-6} or highest segregated HI exceeds 1.0. For each of these grids, the tables identify the COCs and present their contribution to the calculated total risks and hazards for each potentially complete exposure pathway.

The following chemicals are identified as COCs in at least one grid, based on planned reuse and results of the total risk evaluation for soil.

Exposure Scenario	Surface Soil COCs, Total Risk	Subsurface Soil COCs, Total Risk
Industrial[1]	Arsenic Benzo(a)pyrene Benzo(b)fluoranthene Lead	Arsenic Benzo(a)pyrene Benzo(b)fluoranthene Lead
Recreational[1]	Arsenic Benzo(a)pyrene	Not applicable
Residential[1]	Arsenic Iron Manganese Vanadium	Arsenic Iron Nickel Manganese Vanadium
Construction Worker[2]	Not applicable	Arsenic Benzo(a)pyrene Lead Manganese

Notes:

1 COCs identified for this exposure scenario are based on the planned reuse for Parcel D.

2 The construction worker exposure scenario is not associated with a specific planned reuse for Parcel D. Based on discussions and an agreement with the BCT, evaluation of construction worker exposure to soil was based on subsurface soil from 0 to 10 feet bgs, which includes surface soil (0 to 2 feet bgs) exposure.

3.1.3.2 Incremental Risk Evaluation

For the incremental risk evaluation, risks from exposure to COPCs in soil were assessed for both surface soil (0 to 2 feet bgs) and subsurface soil (0 to 10 feet bgs). Figures 3-5 and 3-6 summarize the grid-specific incremental risk results for surface and subsurface soil, respectively, based on the planned reuse of the redevelopment block associated with each grid. Figure 3-7 summarizes the grid-specific incremental risk results for construction worker exposure to soil. The specific calculated incremental cancer risk and noncancer HI results for each grid are listed in Tables 3-8, 3-9, and 3-10.

The risk results shown in the above referenced figures and tables represent incremental risk; that is, all detected chemicals except essential human nutrients and metals below HPALs were included in the risk evaluation. Under the incremental risk evaluation, the most exposure areas at Parcel D do not exceed the cancer risk threshold of 1×10^{-6} or the noncancer threshold HI of 1.0, based on planned reuse.

Tables 3-11, 3-12, and 3-13 present a risk characterization analysis for those grids for which the incremental cancer risk exceeds 1×10^{-6} or highest segregated HI exceeds 1.0. For each of these grids, the tables identify the COCs and present their contribution to the calculated incremental risks and hazards for each potentially complete exposure pathway.

The following chemicals are identified as COCs in at least one grid, based on planned reuse and results of the incremental risk evaluation for soil.

Exposure Scenario	Surface Soil COCs, Incremental Risk	Subsurface Soil COCs, Incremental Risk
Industrial[1]	Arsenic Benzo(a)pyrene Benzo(b)fluoranthene Lead	Arsenic Benzo(a)pyrene Benzo(b)fluoranthene Lead
Recreational[1]	Arsenic Benzo(a)pyrene	Not applicable
Residential[1]	Manganese	Manganese
Construction Worker[2]	Not applicable	Arsenic Benzo(a)pyrene Lead Manganese

Notes:

1 COCs identified for this exposure scenario are based on the planned reuse for Parcel D.

2 The construction worker exposure scenario is not associated with a specific planned reuse for Parcel D. Based on discussions and an agreement with the BCT, evaluation of construction worker exposure to soil was based on subsurface soil from 0 to 10 feet bgs, which includes surface soil (0 to 2 feet bgs) exposure.

3.1.4 Groundwater Risk Summary

Risks from exposure to COPCs in groundwater were assessed for the A- and B-aquifers. Figure 3-8 summarizes the groundwater risk results for each of the identified risk plumes and nonplume exposure areas within the A-aquifer, based on the planned reuse for each redevelopment block. Figure 3-9 summarizes the risk results for construction worker exposure to groundwater, for both plume- and nonplume-based exposures. The results in the figures are shown relative to the cancer risk threshold of 1×10^{-6} and highest segregated noncancer HI of 1.0.

Tables 3-14 and 3-15 present a risk characterization analysis for those exposure areas for which the cancer risk exceeds 1×10^{-6} or the highest segregated HI exceeds 1.0, for the exposure scenarios associated with planned reuse and the construction worker scenario, respectively. These tables identify the groundwater COCs associated with each Parcel D risk plume and the percent contribution of each COC to the total cancer risk and HI calculated for each plume. Exposure areas not associated with risk plumes with COCs are also shown on Tables 3-14 and 3-15. The following chemicals are identified as COCs in groundwater in the A-aquifer, based on planned reuse.

Exposure Scenario	Groundwater COCs, A-Aquifer
Industrial[1]	Benzene, Carbon Tetrachloride, Chloroform, Naphthalene, Tetrachloroethene, Trichloroethene, and Xylenes
Recreational[1]	Not applicable
Residential[1]	Chloroform, Methylene Chloride, and Trichloroethene
Construction Worker[2]	Arsenic, Benzene, Naphthalene, Tetrachloroethene, and Xylenes

Notes:

1 COCs identified for this exposure scenario are based on the planned reuse for Parcel D.

2 The construction worker exposure scenario is not associated with a specific planned reuse for Parcel D

Evaluation of exposure to groundwater in the B-aquifer was limited to residential exposure from domestic use. No COCs were identified for domestic use in the B-aquifer.

Figure 3-10 shows the risk results from residential exposure to groundwater in the B-aquifer from domestic use. As discussed in the HHRA (see Appendix B), risks from exposure to groundwater in the B-aquifer were evaluated for each exposure area for which monitoring data for the B-aquifer are available, regardless of the specific planned reuse of the exposure area. In addition, although contaminant plumes have not been identified in the B-aquifer and hydraulic communication does not occur between the A- and B-aquifers at Parcel D, data collected from the B-aquifer were grouped using the same risk plume delineation boundaries developed to evaluate risks for the A-aquifer. This approach was selected to facilitate reporting of risk results over collocated exposure areas. One A-aquifer plume-based exposure area (IR-71) and two A-aquifer nonplume-exposure areas (grid numbers 082075 and 085079) were evaluated for exposure to groundwater in the B-aquifer. Cancer risks were below 1×10^{-6} and noncancer HIs were below 1.0 for each of these exposure areas in the B-aquifer; hence, COCs were not identified for the B-aquifer at Parcel D.

3.2 ENVIRONMENTAL EVALUATION

Chemicals present in both the A-aquifer and the B-aquifer groundwater at Parcel D were evaluated to assess potential environmental impacts to the Bay. This evaluation was completed as part of the derivation of trigger levels for chemicals that present a potential impact to the Bay in Appendix I. The first step of this evaluation consisted of a screening-level comparison of chemical concentrations measured in groundwater to surface water criteria and HGAL (for metals only). Appendix H lists available state and federal surface water criteria and summarizes the criteria selected for use in the screening-level evaluation. Although complete exposure pathways from known groundwater plumes at Parcel D to the Bay are not known to currently exist, a potential threat to the Bay exists if chemicals currently present in groundwater at concentrations above the screening criteria reach the Bay.

Concentrations of all chemicals detected in the A- and B-aquifers were compared to the selected screening criteria; those chemicals for which maximum concentrations exceeded screening criteria were identified as COPECs. This comparison is shown in Appendix H, Section H3.0. As shown in these tables, 12 COPECs were identified as a result of this comparison (9 metals; a VOC, ethylbenzene; an SVOC, acenaphthylene; and cyanide).

The next step of the environmental evaluation involved a well-by-well analysis of the analytical results for the 12 identified COPECs to assess potential threats to the Bay (see Appendix H, Section H3.0). Based on this evaluation, chromium VI and nickel were identified as COCs in the A-aquifer based on the environmental evaluation in Appendix H.

- **Chromium VI** is identified as a COC due to detections in both the defined plumes and in individual wells in the A-aquifer, which contain concentrations of this metal that consistently exceeded the surface water criteria. The locations of the elevated chromium VI concentrations are mostly near IR-09 where there was a known source of chromium from painting operations. Twenty-five samples contained concentrations exceeding the surface water criteria based on results from 171 groundwater samples collected from the A-aquifer at Parcel D. Consistent elevated concentrations of chromium VI were detected in wells IR09MW35A and IR09PPY1, and recent results exceeded the surface water screening criteria in groundwater from wells IR09MW63A and IR33MW61A. Chromium VI is also present in several other A-aquifer wells at Parcel D, although it does not exceed the surface water criteria. No chromium VI was detected in samples collected from the B-aquifer. The current locations of chromium VI in the A-aquifer groundwater at Parcel D are not near the Bay and do not appear to pose an immediate threat to the surface water.

- **Nickel** is identified as a COC due to detections in a single well that consistently exceeded surface water criteria, and historical detections of nickel in an adjacent well that also exceeded surface water criteria. These concentrations of nickel indicate a localized area of nickel-impacted groundwater. The source of the nickel is not known. 121 samples contained concentrations exceeding the surface water criteria, and 18 samples contained concentrations exceeding the HGAL for nickel, based on results from 275 groundwater samples collected at Parcel D. Consistent elevated concentrations of nickel were detected in well IR09P043A and sporadic detections of nickel that exceeded the HGAL were detected in other nearby wells. Nickel is also present in samples from several other A-aquifer wells at Parcel D. However, results from these samples do not exceed the respective HGAL, indicating natural concentrations of nickel from the native and non-native soils in contact with the A-aquifer. Nickel was not detected at concentrations exceeding the surface water criteria in the B-aquifer. The current location of elevated nickel in the A-aquifer groundwater at Parcel D is not near the Bay and does not appear to pose an immediate threat to the surface water.

The other 10 COPECs were not identified as COCs during the evaluation in Appendix H.

3.3 REMEDIATION GOALS AND GROUNDWATER TRIGGER LEVELS

Remediation goals were developed for the COCs identified for soil and groundwater, using the methodology described below. In accordance with CERCLA guidance, development of remediation goals for soil was limited to the COCs identified based on the incremental risk evaluation, which excludes the risks posed by metals at concentrations below ambient levels. Remedial goals for groundwater were developed based on the results of the HHRA accounting for the HGAL levels.

An ecological evaluation was performed to assess whether groundwater was impacting surface water. Trigger levels were developed for this pathway as part of this ecological evaluation for groundwater plumes identified as potential risks to the surface water of the Bay. The trigger levels are unique to each plume source, primarily based on the source width and the distance from the plume source to the Bay, and are a means of relating the surface water quality criteria to the groundwater. As explained below, the trigger levels would provide a means to determine when further studies or remedial action may be required to protect the Bay.

3.3.1 Soil

Remediation goals for COCs in soil were selected based on a comparison of the COC-specific RBC, the laboratory practical quantitation limit (PQL) based on standard EPA analytical methods, and the HPAL (metals only). The highest of these three concentrations was selected as the remediation goal for soil for each COC. Exposure scenario-specific RBCs were calculated based on a target cancer risk level of 1×10^{-6} and target noncancer HI of 1.0, consistent with the exposure pathways and assumptions used in the HHRA to assess risks. Table 3-16 presents the remediation goals for COCs in soil.

3.3.2 Groundwater

Remediation goals for COCs in groundwater in the A-aquifer are shown in Table 3-17. Development of the remediation goals for groundwater was based on consideration of exposure scenario-specific RBCs, laboratory PQLs, and HGALs (for metals only). Exposure scenario-specific screening levels based on a target cancer risk level of 1×10^{-6} and a target noncancer HI of 1.0 were used as RBCs for groundwater; these RBCs were calculated consistent with the exposure pathways used in the HHRA to assess risks from exposure to groundwater. The RBCs for A-aquifer COCs for the residential and industrial scenarios were based on inhalation of volatile chemicals from groundwater. The RBCs for A-aquifer COCs for the construction worker scenario were based on dermal contact with and vapor inhalation of A-aquifer groundwater. Chemical-specific ARARs were not considered in the development of the remediation goals for groundwater because none are available to address the exposure pathways assessed for the A-aquifer (see Section 4.2).

For organic COCs, the chemical-specific RBC is used as the remediation goal. However, the remediation goal defaults to the laboratory PQL if the RBC is lower than the PQL, because the RBC would not be detectable at concentrations below the PQL. For inorganic chemicals, this same hierarchy applied for selection of remediation goals except that the HGAL (metals only) is selected as the remediation goal if it exceeds the RBC and is greater than the laboratory PQL.

3.3.3 Sampling Locations with Chemical Concentrations Above Remediation Goals

A list of soil sampling locations with chemical concentrations above remediation goals was compiled to identify those locations at Parcel D for which remedial action is required, based on planned reuse. Tables 3-18 and 3-19 show the soil sampling locations with measured concentrations of COCs above remediation goals for surface and subsurface soil, respectively.

Groundwater risk plumes with measured concentrations above remediation goals are shown on Figure 4-2 and are discussed further in Section 4.1.2.1.

3.3.4 Groundwater Ecological Screening and Trigger Levels

Groundwater at Parcel D is in contact with a tidal influence zone along the shoreline and with the surface water to the Bay. An ecological screening was performed to assess if the concentration of analytes detected in the groundwater could potentially impact the Bay water. This screening was a comparison of the promulgated acceptable surface water criteria with the detected concentrations in the groundwater at Parcel D, and a point-by-point evaluation of the analytical history where groundwater concentrations exceeded the surface water criteria. The details of this screening and evaluation are included in Appendix H.

The ecological screening at Parcel D indicated that three chromium VI plumes and one nickel plume in the A-aquifer were present at persistently high concentrations that could potentially impact the Bay. Therefore, chromium VI and nickel were identified as COCs. No COCs were identified in the B-aquifer at Parcel D. The chromium VI and nickel plumes identified as potential threats to the Bay are inland from the tidal mixing zone and the shoreline and are not presently in contact with the Bay water; therefore, these COCs only pose a potential future threat to the Bay.

To assess the degree of each COC's potential future threat to the Bay, a trigger level was developed as a plume-specific value that applies only to the location at which it had been derived for that analyte. The trigger level was based on the surface water criterion that is protective of the Bay, but applied an attenuation factor that conservatively accounts for dispersion of the COC as it moves through the A-aquifer toward the Bay. The trigger levels are concentrations greater than the surface water criteria, but low enough at the specific plume location that the COC concentrations would be less than the surface water criteria once the COC moved through the aquifer and discharged to the Bay. A comparison of the plume-specific trigger levels with the concentration of the COC at the source of the plume was used to assess the degree of potential future threat to the Bay, and served to determine if additional studies or remedial actions would be needed. A more detailed description of the trigger level development is included in Appendix I, and is summarized below.

3.3.4.1 Development of Trigger Levels for Groundwater

Appropriate surface water criteria for the protection of the Bay were selected based on established surface water quality criteria. Formulation of selection criteria involved reference to chronic criteria if available, or acute criteria adjusted for chronic conditions if no chronic criteria were available. The lowest level of the two criteria applying to the same exposure scenario was selected.

No such surface water quality criteria for groundwater are available that would be protective of the Bay. Direct application of the surface water criteria to groundwater to protect aquatic organisms from groundwater discharging to a surface water body is not appropriate because chemical concentrations in groundwater tend to attenuate as the groundwater migrates toward its discharge point, and as it mixes with surface water at the discharge point. For HPS, three discrete zones exist along the groundwater migration pathway: (1) the zone of groundwater transport from the source area to the tidal mixing zone, (2) the tidal mixing zone, and (3) the zone of groundwater discharge to the surface water body. Attenuation in the zone of groundwater transport occurs because of hydrodynamic dispersion, sorption, and biological and chemical transformations. Attenuation in the tidal mixing zone occurs because of those processes, and also because of dilution from surface water mixing with groundwater when high tides move Bay water inland into the aquifer. Attenuation in the groundwater discharge zone occurs primarily because of dilution with the much larger volume of water present in the surface water body.

Estimates of the amount of attenuation in each of these zones can result from various types of modeling. The model described in Appendix G includes two evaluations of attenuation factors at Parcel D: (1) a sensitivity evaluation to determine the input variables with the greatest effect on deriving attenuation factors, and (2) application of the most sensitive parameters among a variety of input parameters to obtain attenuation factors. The application of the model in Appendix G applied a conservative approach of deriving attenuation factors assuming hydrodynamic dispersion in the groundwater transport zone as the only transport mechanism. This application assumes that the dispersion of the chemicals is the same as the dispersion rate of the groundwater; therefore, this model is not chemical specific and can be applied to derive conservative attenuation factors for all analytes found at Parcel D.

The modeling results using this conservative approach indicate that ranges of attenuation factors can be substantial, depending upon the width of the plume and the distance to the discharge point. Applying this conservative dispersion model results in a location- or plume-specific attenuation factors because the distance to the discharge point was determined a primary sensitive variable. The resulting attenuation factors for the chromium VI and nickel plumes at Parcel D, which are 1,100 to 1,500 feet to the nearest discharge point, range from 12 to 18.

To assess the degree of each COC's potential threat to the Bay, a trigger level was developed as a plume-specific value (applying only to the location at which it had been derived for that analyte) for comparison with the detected site or plume value. The trigger level is a means of applying the surface water quality criteria to the groundwater at the plume's source using the attenuation factor. The comparison of the trigger levels to the plume's source levels served to determine if further studies or remedial actions would be needed.

Plume-specific trigger levels were developed for the COCs by multiplying the appropriate attenuation factor calculated for the groundwater transport zone times the surface water quality criterion for the COCs that potentially threaten the Bay. Trigger levels were developed for chromium VI and nickel derived from transport modeling, the surface water quality criteria, and the HGAL. These trigger levels reflect the following conservative assumptions:

1. The groundwater modeling for the transport zone assumed no sorption or biological/chemical transformation reactions, and relied exclusively on hydrodynamic dispersion for attenuation of chemical concentrations.

2. The attenuation factor did not include attenuation in the tidal mixing zone or attenuation upon discharge into the Bay, and included only attenuation in the groundwater transport zone.

3. The surface water quality criterion selected for some metals was derived from the chronic exposure scenario, even though the attenuation factor model assumed that groundwater did not mix with the Bay water. Under a no-mixing scenario, the appropriate water quality criterion would be the acute scenario, which typically is a higher number.

Nevertheless, the Navy agreed to use highly conservative measures throughout the trigger level evaluation, as agreed to with the regulatory agencies. The table below summarizes the derived attenuation factors and the proposed trigger levels for the COCs determined as potential threats to the Bay.

Area	Attenuation Factor	HPS HGAL (µg/L)	Surface Water Quality ARARs[1] (µg/L)	Practical Quantitation Limit (µg/L)	Proposed Trigger Level at Plume Source (µg/L)	Maximum Concentration at Plume Source Well (µg/L)	Maximum Source Concentration Exceeds Proposed Trigger Level?
IR-09 North, chromium VI	12	NA	**50**	0.5	600	493	No
IR-09 South, chromium VI	18	NA	**50**	0.5	900	130	No
IR-09 South, nickel	16	**96.48**	8.2	0.7	1,544	185	No
IR-33, chromium VI	14	NA	**50**	0.5	700	250	No

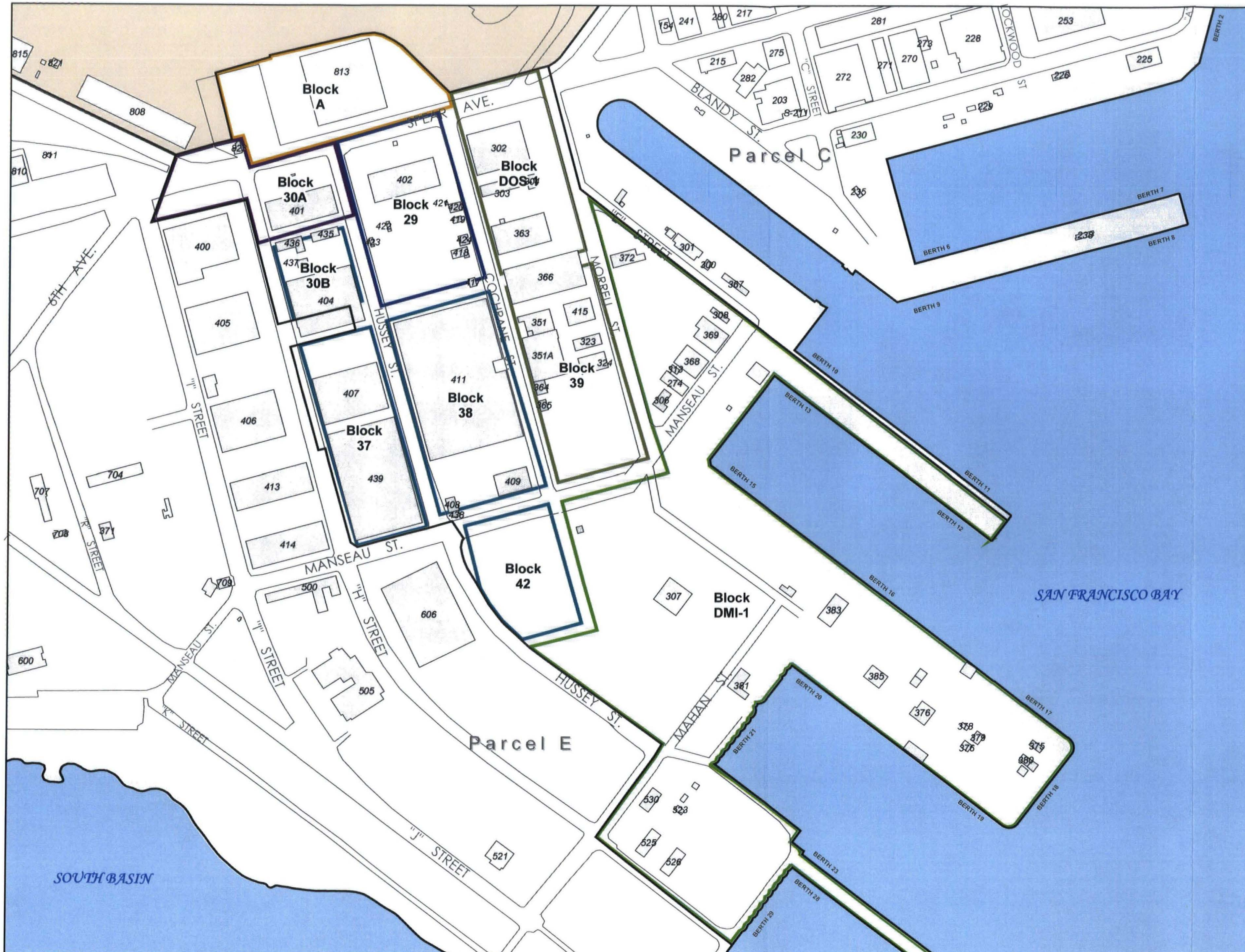
Notes:

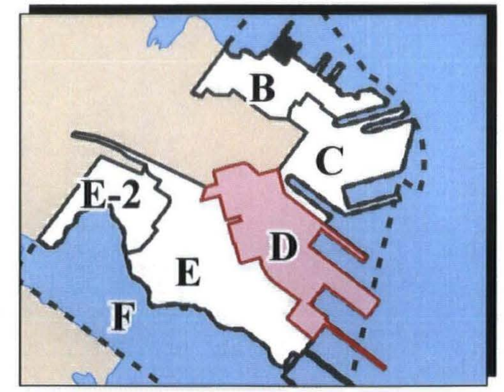
1 Surface Water Quality ARARs are shown in Table H-1 of Appendix H – *Preliminary Screening for Groundwater Impacts to San Francisco Bay* as either Table 3-3 to the San Francisco Bay Basin Plan, or the California Toxics Rule Criteria for Enclosed Bays and Estuaries, if no value is listed for the San Francisco Bay Basin Plan.

µg/L Micrograms per liter
NA Not available

Comparing the resulting trigger levels with the maximum source area concentrations in the plume areas indicated that no concentration at the plume's source exceeded its trigger level. The groundwater monitoring plan for Parcel D will address the need to monitor concentrations in the plume, temporal stability of the plume, and the degree (if any) of plume migration toward the Bay. Based on the calculated trigger levels and a comparison with the maximum source plume concentrations, the expected attenuation will be sufficient to prevent the COCs from the Parcel D plumes from discharging to the Bay at levels above surface water quality criteria (surface water ARARs).

FIGURES





Location Map

Road

Parcel D Redevelopment Blocks;

- Industrial
- Research and Development
- Mixed Use
- Open Space
- Maritime Industrial
- Educational/Cultural
- 401 Building
- Parcel Boundary
- Non-Navy Property
- San Francisco Bay

Note:
Redevelopment blocks are based on the planned reuses provided in "Hunters Point Shipyard Redevelopment Plan," San Francisco Redevelopment Agency, July 14, 1997.

N

0 350 700

Scale in Feet

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Hunters Point Shipyard, San Francisco, California

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 3-1
PARCEL D
REDEVELOPMEMT BLOCKS
AND PLANNED REUSES

Revised Feasibility Study Report for Parcel D

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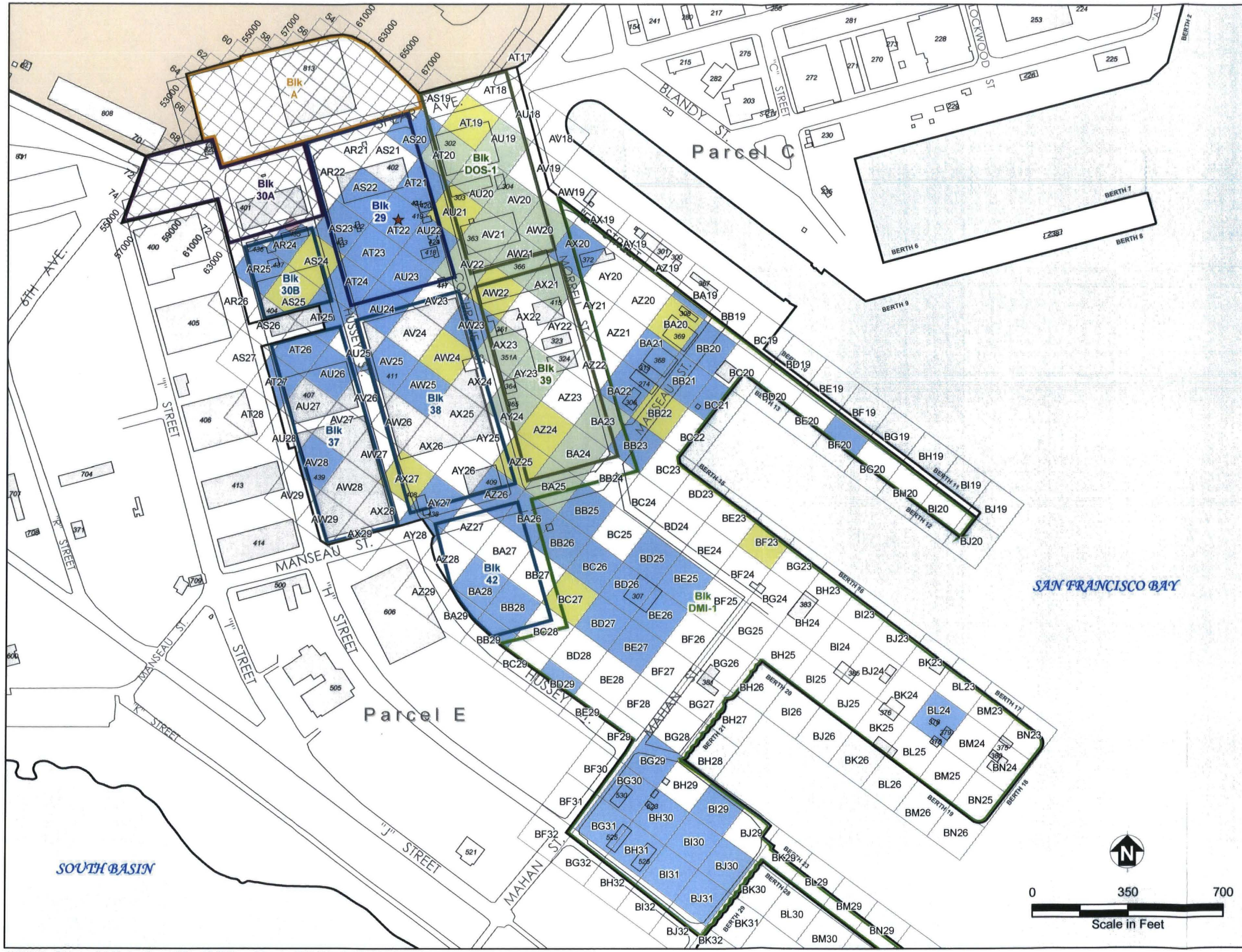

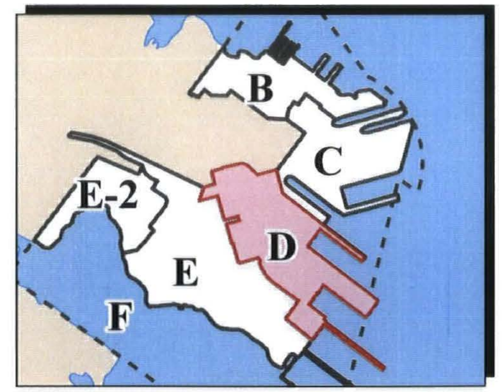

Location Map

★	Industrial Lead Concentration > 800 mg/kg
	Road
	Residential Cancer Risk > 1E-06
	Industrial Cancer Risk > 1E-06
	Recreational Cancer Risk > 1E-06
	Cancer Risk ≤ 1E-06
	Highest Segregated Hazard Index > 1
	No Data
	Parcel Boundary
	Industrial
	Research and Development
	Mixed Use
	Open Space
	Maritime Industrial
	Educational/Cultural
401	Building
	Non-Navy Property
	San Francisco Bay

Notes:
1. A 50-foot by 50-foot exposure area (residential grid) is used to evaluate risks associated with Mixed Use and Research and Development planned reuses.
2. A 150-foot by 150-foot exposure area (industrial grid) is used to evaluate risks associated with Industrial, Maritime Industrial, and Educational/Cultural planned reuses.

Blk Block
ft bgs Feet below ground surface
mg/kg Milligram per kilogram

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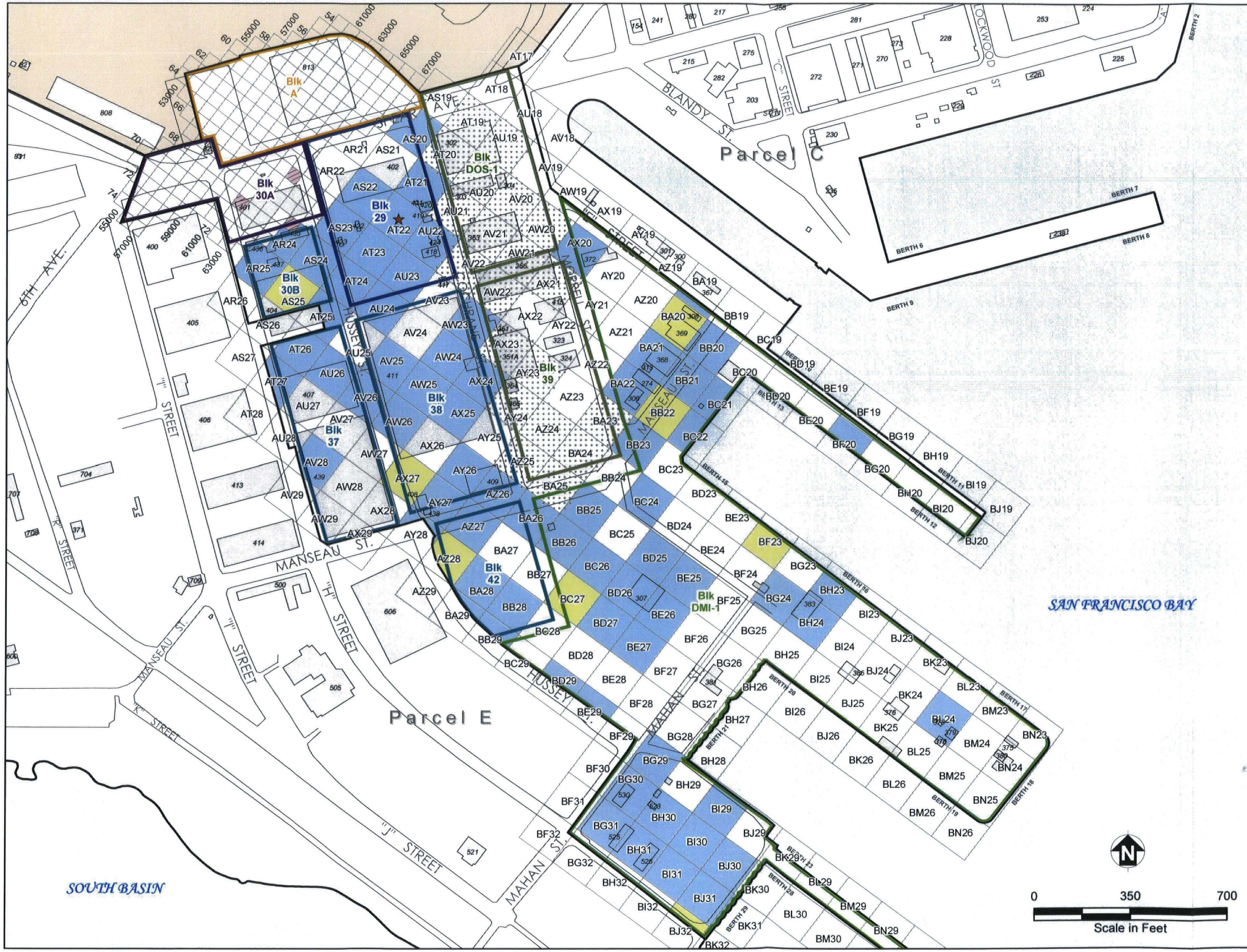
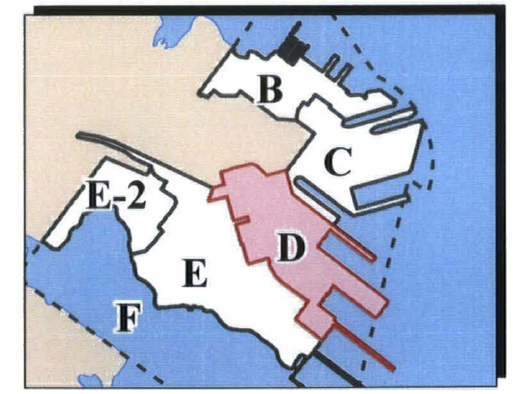
FIGURE 3-2
TOTAL RISK - SURFACE SOIL (0 TO 2 FT BGS) RISKS BASED ON PLANNED REUSE

Revised Feasibility Study Report for Parcel D





Location Map

- ★ Industrial Lead Concentration > 800 mg/kg
- Road
- Residential Cancer Risk > 1E-06
- Industrial Cancer Risk > 1E-06
- Cancer Risk ≤ 1E-06
- Highest Segregated Hazard Index > 1
- Data Available; Recreational Scenario Not Evaluated for Subsurface Soil
- No Data
- Parcel Boundary
- Industrial
- Research and Development
- Mixed Use
- Open Space
- Maritime Industrial
- Educational/Cultural
- 401 Building
- Non-Navy Property
- San Francisco Bay

Notes:
1. A 50-foot by 50-foot exposure area (residential grid) is used to evaluate risks associated with Mixed Use and Research and Development planned reuses.
2. A 150-foot by 150-foot exposure area (industrial grid) is used to evaluate risks associated with Industrial, Maritime Industrial, and Educational/Cultural planned reuses.

Blk Block
ft bgs Feet below ground surface
mg/kg Milligram per kilogram

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FIGURE 3-3
TOTAL RISK - SUBSURFACE SOIL (0 TO 10 FT BGS) RISKS BASED ON PLANNED REUSE
Revised Feasibility Study Report for Parcel D

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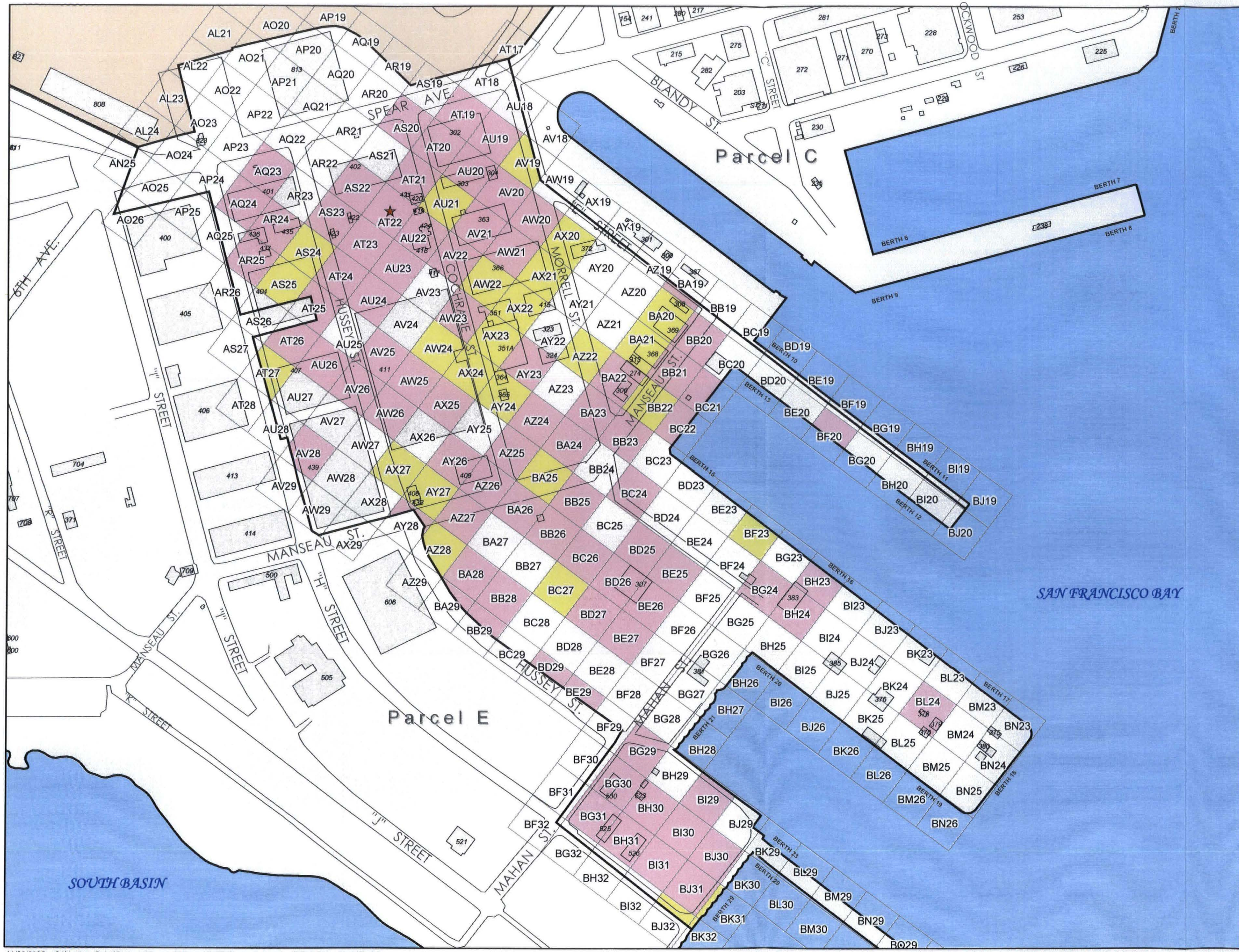

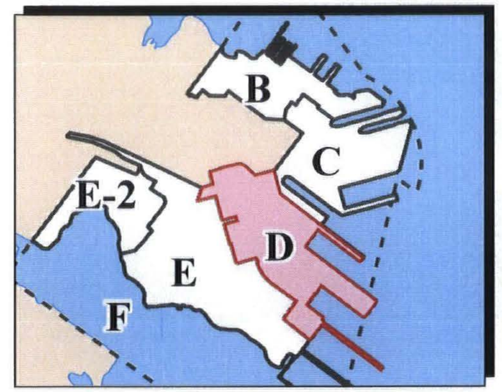

Location Map

★ Industrial Lead Concentration > 800 mg/kg

Road

Construction Worker Cancer Risk > 1E-06

Construction Worker Cancer Risk ≤ 1E-06

No Data

Parcel Boundary

401 Building

Non-Navy Property

San Francisco Bay

Notes:

1. Highest segregated hazard indices ≤ 1 for all grids with data.
2. A 150-foot by 150-foot exposure area (industrial grid) is used to evaluate risks associated with construction worker exposures.

ft bgs Feet below ground surface
mg/kg Milligram per kilogram

N

0 350 700

Scale in Feet

SulTech

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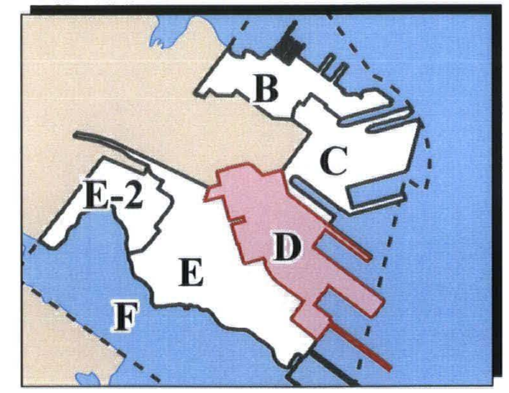
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 3-4

TOTAL RISK - SUBSURFACE SOIL (0 TO 10 FT BGS) RISKS, CONSTRUCTION WORKER EXPOSURE SCENARIO

Revised Feasibility Study Report for Parcel D



Location Map

- ★ Industrial Lead Concentration > 800 mg/kg
- Road
- Industrial Cancer Risk > 1E-06
- Recreational Cancer Risk > 1E-06
- Cancer Risk ≤ 1E-06
- Highest Segregated Hazard Index > 1
- Parcel Boundary
- No Data
- Industrial
- Research and Development
- Mixed Use
- Open Space
- Maritime Industrial
- Educational/Cultural
- 401 Building
- Non-Navy Property
- San Francisco Bay

Notes:

1. A 50-foot by 50-foot exposure area (residential grid) is used to evaluate risks associated with Mixed Use and Research and Development planned reuses.
2. A 150-foot by 150-foot exposure area (industrial grid) is used to evaluate risks associated with Industrial, Maritime Industrial, and Educational/Cultural planned reuses.

Blk Block
ft bgs Feet below ground surface
mg/kg Milligram per kilogram

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FIGURE 3-5
INCREMENTAL RISK - SURFACE SOIL (0 TO 2 FT BGS) RISKS BASED ON PLANNED REUSE

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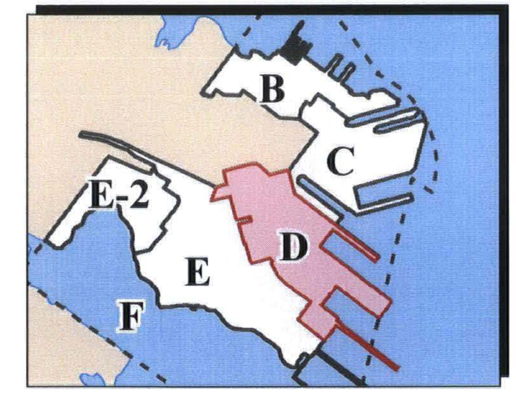

Location Map

★ Industrial Lead Concentration > 800 mg/kg
Road
Industrial Cancer Risk > 1E-06
Cancer Risk ≤ 1E-06
Highest Segregated Hazard Index > 1
Parcel Boundary
Data Available; Recreational Scenario Not Evaluated for Subsurface Soil
No Data
Industrial
Research and Development
Mixed Use
Open Space
Maritime Industrial
Educational/Cultural
401 Building
Non-Navy Property
San Francisco Bay

Notes:
1. A 50-foot by 50-foot exposure area (residential grid) is used to evaluate risks associated with Mixed Use and Research and Development planned reuses.
2. A 150-foot by 150-foot exposure area (industrial grid) is used to evaluate risks associated with Industrial, Maritime Industrial, and Educational/Cultural planned reuses.

Blk Block
ft bgs Feet below ground surface
mg/kg Milligram per kilogram

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FIGURE 3-6
INCREMENTAL RISK - SUBSURFACE SOIL (0 TO 10 FT BGS) RISKS BASED ON PLANNED REUSE
Revised Feasibility Study Report for Parcel D

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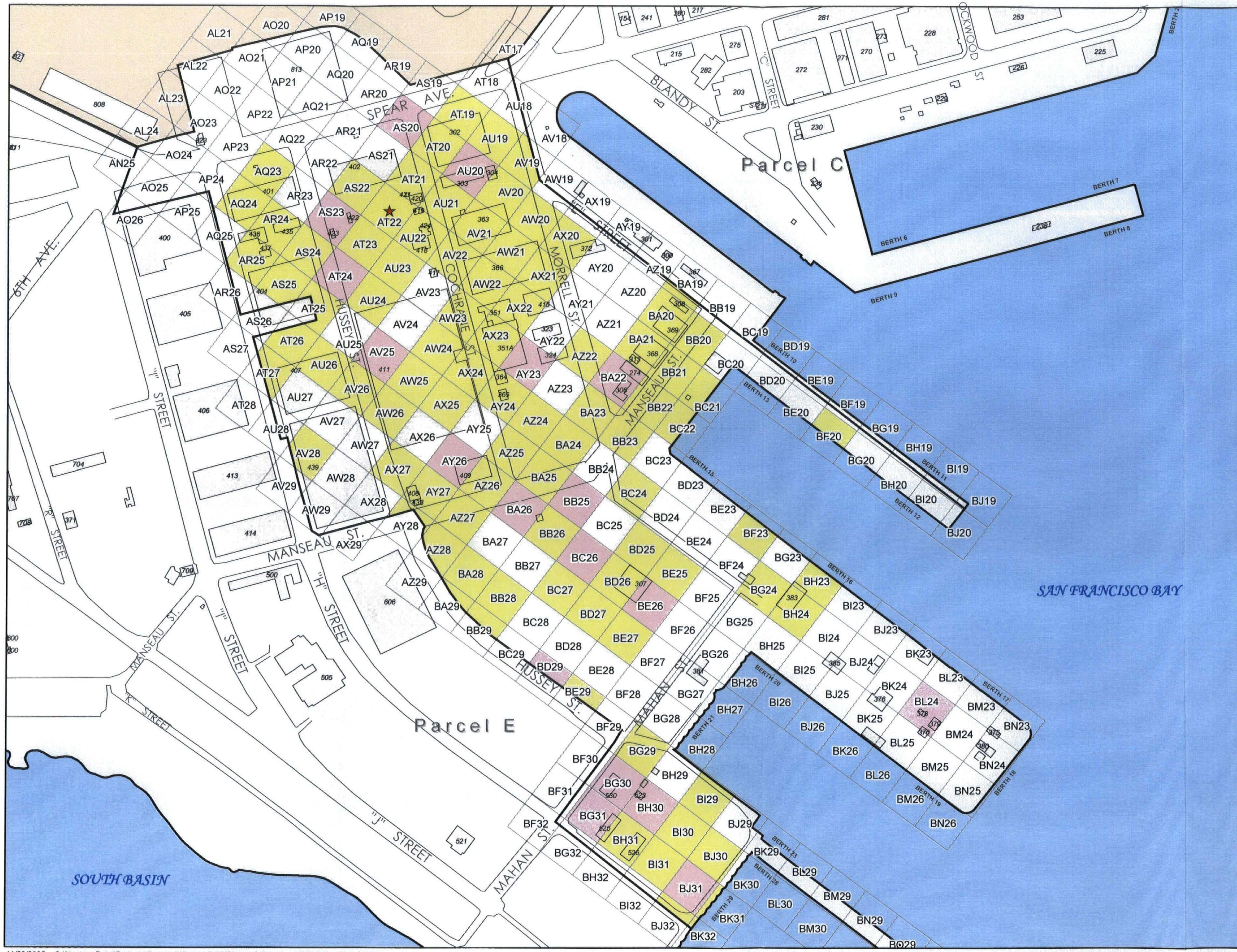

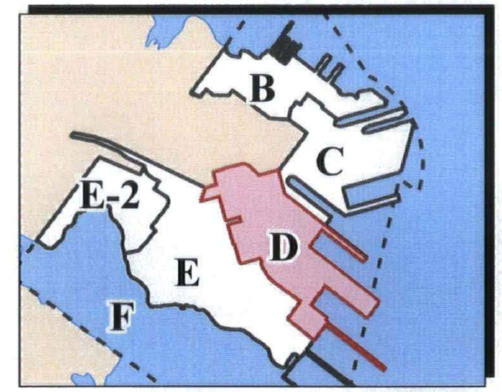

Location Map

- ★ Industrial Lead Concentration > 800 mg/kg
- Road
- Construction Worker Cancer Risk > 1E-06
- Construction Worker Cancer Risk ≤ 1E-06
- Parcel Boundary
- No Data
- 401 Building
- Non-Navy Property
- San Francisco Bay

Notes:
1. Highest segregated hazard indices ≤ 1 for all grids with data.
2. A 150-foot by 150-foot exposure area (industrial grid) is used to evaluate risks associated with construction worker exposures.

ft bgs Feet below ground surface
mg/kg Milligram per kilogram

N

0 350 700
Scale in Feet

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FIGURE 3-7
INCREMENTAL RISK - SUBSURFACE SOIL (0 TO 10 FT BGS) RISKS, CONSTRUCTION WORKER EXPOSURE SCENARIO
Revised Feasibility Study Report for Parcel D

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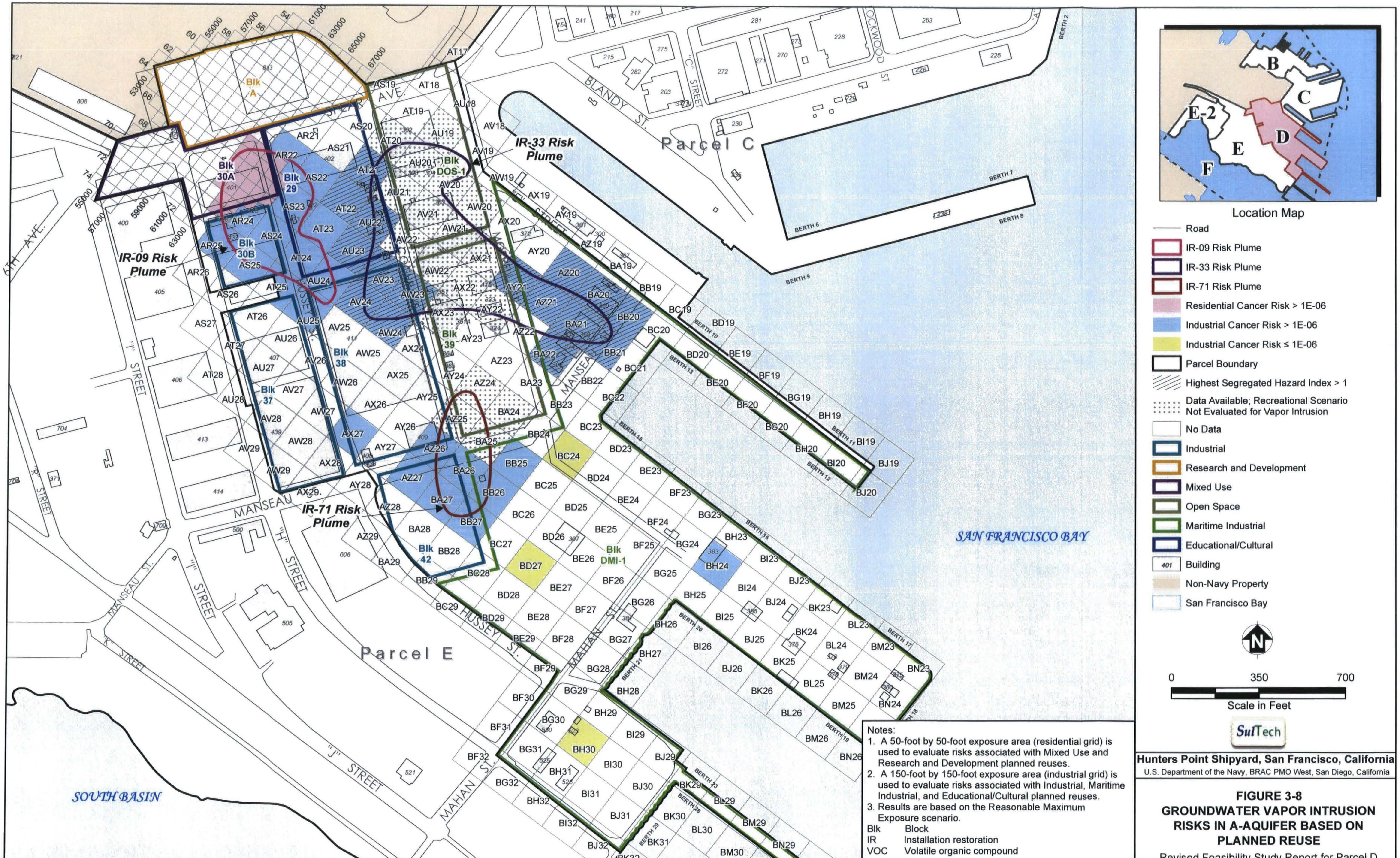

FIGURE 3-8
GROUNDWATER VAPOR INTRUSION RISKS IN A-AQUIFER BASED ON PLANNED REUSE
Revised Feasibility Study Report for Parcel D

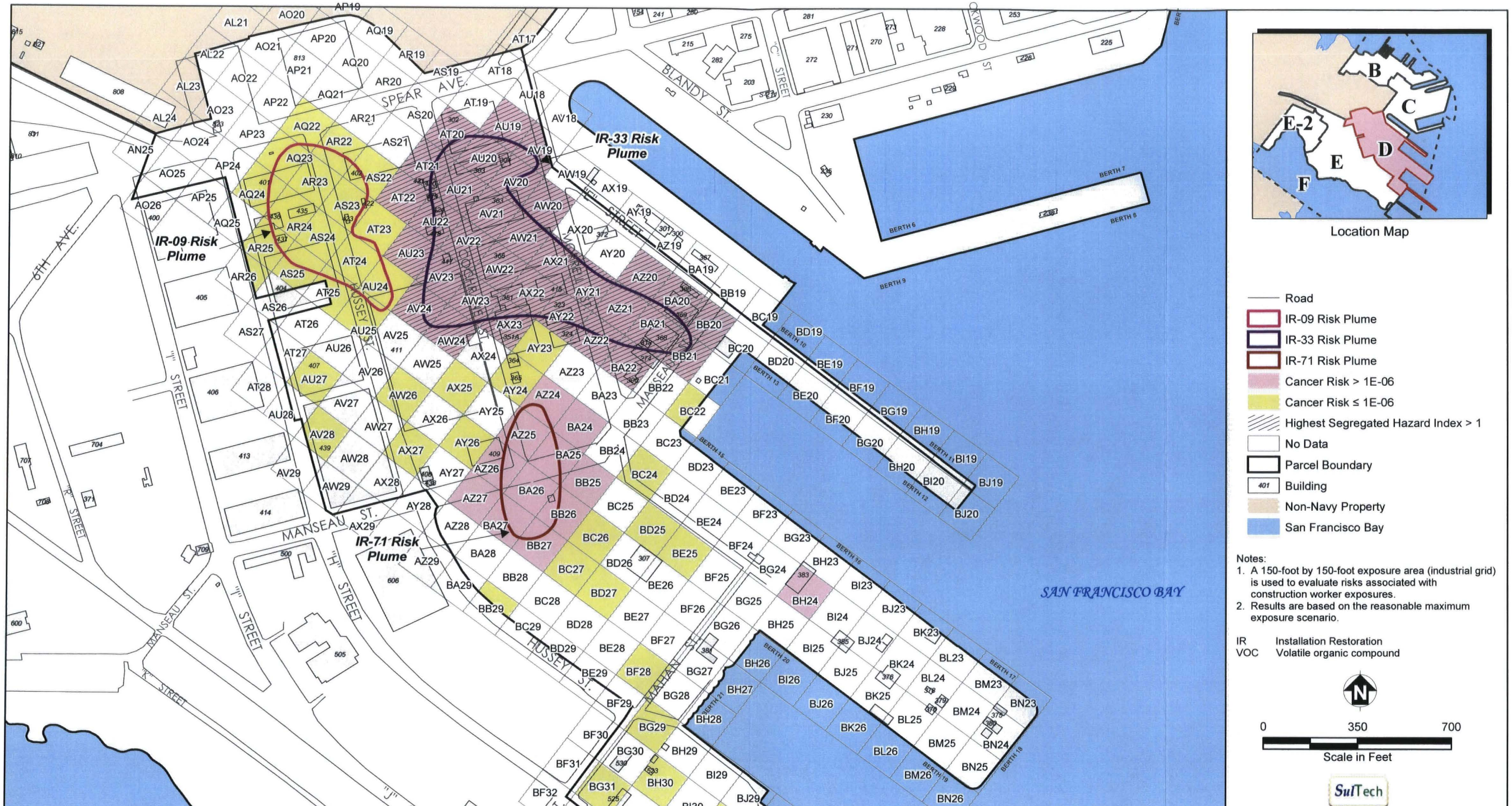

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FIGURE 3-9
TRENCH GROUNDWATER RISKS IN A-AQUIFER, CONSTRUCTION WORKER EXPOSURE SCENARIO

Revised Feasibility Study Report for Parcel D

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TABLES

TABLE 3-1: HUMAN HEALTH RISK ASSESSMENT POTENTIAL COMPLETE EXPOSURE PATHWAYS

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

		Soil								Groundwater						
		0 – 2 feet				0 – 10 feet				A-Aquifer				B-Aquifer and Bedrock		
Exposure Scenario	Grid Size	Ingestion	Dermal	Inhalation (particulates and VOCs)	Home-grown Produce	Ingestion	Dermal	Inhalation (particulates and VOCs)	Home-grown Produce	Ingestion	Dermal	Inhalation (vapor intrusion)	Inhalation (construction trench)	Ingestion	Dermal	Inhalation (house-hold use)
Residential	2,500 square feet	●	●	●	●	●	●	●	●	--	--	●	--	●	●[a]	●
Industrial	0.5 acre	●	●	●	--	●	●	●	--	--	--	●	--	--	--	--
Recreational	0.5 acre	●	●	●	--	--	--	--	--	--	--	--	--	--	--	--
Construction	0.5 acre	--	--	--	--	●	●	●	--	--	●	--	●	--	--	--

Notes:

a	Addressed in Section B9.0, Uncertainty Analysis, of the HHRA
●	Quantitatively evaluated in HHRA
--	Not quantitatively evaluated in HHRA
HHRA	Human health risk assessment
VOC	Volatile organic compound

TABLE 3-2: TOTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 2 FEET BGS)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
DMI-1	MI	AX20	**2E-06**	<1	<1
DMI-1	MI	BA19	**6E-06**	<1	<1
DMI-1	MI	BA20	2E-08	<1	<1
DMI-1	MI	BA21	**3E-06**	<1	<1
DMI-1	MI	BA22	**2E-05**	<1	<1
DMI-1	MI	BA26	**3E-05**	<1	<1
DMI-1	MI	BB20	**2E-05**	<1	<1
DMI-1	MI	BB21	**2E-05**	<1	<1
DMI-1	MI	BB22	6E-08	<1	<1
DMI-1	MI	BB23	**9E-06**	<1	<1
DMI-1	MI	BB25	**3E-05**	<1	<1
DMI-1	MI	BB26	**1E-05**	<1	<1
DMI-1	MI	BC21	**1E-05**	<1	<1
DMI-1	MI	BC26	**2E-05**	<1	<1
DMI-1	MI	BC27	2E-08	<1	<1
DMI-1	MI	BD25	**2E-05**	<1	<1
DMI-1	MI	BD26	**8E-06**	<1	<1
DMI-1	MI	BD27	**1E-05**	<1	<1
DMI-1	MI	BD29	**2E-05**	<1	<1
DMI-1	MI	BE25	**2E-05**	<1	<1
DMI-1	MI	BE26	**2E-05**	<1	<1
DMI-1	MI	BE27	**2E-05**	<1	<1
DMI-1	MI	BF20	**9E-06**	<1	<1
DMI-1	MI	BF23	3E-08	<1	<1
DMI-1	MI	BG29	**9E-06**	<1	<1
DMI-1	MI	BG30	**2E-05**	<1	<1
DMI-1	MI	BG31	**2E-05**	<1	<1
DMI-1	MI	BH30	**3E-05**	<1	<1
DMI-1	MI	BH31	**2E-05**	<1	<1
DMI-1	MI	BI29	**1E-05**	<1	<1
DMI-1	MI	BI30	**2E-05**	<1	<1
DMI-1	MI	BI31	**6E-06**	<1	<1
DMI-1	MI	BJ30	**2E-05**	<1	<1
DMI-1	MI	BJ31	**3E-05**	<1	<1
DMI-1	MI	BL24	**3E-05**	<1	<1
30B	IND	AR24	**8E-06**	<1	<1
30B	IND	AR25	**2E-05**	<1	<1
30B	IND	AS24	1E-08	<1	<1
30B	IND	AS25	2E-08	<1	<1
30B	IND	AT25	**4E-06**	<1	<1
37	IND	AT26	**2E-05**	<1	<1
37	IND	AT27	**3E-06**	<1	<1
37	IND	AU26	**2E-05**	<1	<1
37	IND	AV28	**2E-05**	<1	<1
38	IND	AU24	**2E-05**	<1	<1
38	IND	AV25	**7E-06**	<1	<1
38	IND	AW23	**1E-05**	<1	<1
38	IND	AW24	2E-08	<1	<1
38	IND	AW25	**1E-05**	<1	<1
38	IND	AX27	6E-09	<1	<1
38	IND	AY27	**5E-06**	<1	<1
38	IND	AZ26	**1E-05**	<1	<1

TABLE 3-2: TOTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 2 FEET BGS) (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
42	IND	AY28	**2E-05**	<1	<1
42	IND	BA28	**7E-06**	<1	<1
42	IND	BA29	**1E-05**	<1	<1
42	IND	BB28	**9E-06**	<1	<1
42	IND	BB29	**2E-05**	<1	<1
29	E/C	AS20	**2E-05**	<1	<1
29	E/C	AS22	**7E-06**	<1	<1
29	E/C	AS23	**3E-05**	<1	<1
29	E/C	AT21	**8E-06**	<1	<1
29	E/C	AT22	**2E-05**	<1	<1
29	E/C	AT23	**1E-05**	<1	<1
29	E/C	AT24	**3E-05**	<1	<1
29	E/C	AU22	**2E-05**	<1	<1
29	E/C	AU23	**1E-05**	<1	<1
29	E/C	AV22	**8E-06**	<1	<1
DOS-1	OS	AT19	2E-08	<1	<1
DOS-1	OS	AT20	**2E-05**	<1	<1
DOS-1	OS	AU19	**1E-05**	<1	<1
DOS-1	OS	AU20	**1E-05**	<1	<1
DOS-1	OS	AU21	2E-08	<1	<1
DOS-1	OS	AV20	**1E-05**	<1	<1
DOS-1	OS	AV21	**8E-06**	<1	<1
DOS-1	OS	AW20	**1E-05**	<1	<1
DOS-1	OS	AW21	**1E-05**	<1	<1
39	OS	AW22	3E-09	<1	<1
39	OS	AX21	**1E-05**	<1	<1
39	OS	AX23	**4E-06**	<1	<1
39	OS	AY23	**1E-04**	<1	<1
39	OS	AY24	**3E-06**	<1	<1
39	OS	AZ24	4E-09	<1	<1
39	OS	AZ25	3E-07	<1	<1
39	OS	BA23	**2E-05**	<1	<1
39	OS	BA24	**1E-05**	<1	<1
39	OS	BA25	**4E-06**	<1	<1
30A	MU	066068	**9E-05**	7E+00	**3E+00**

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1.0 for segregated noncancer hazards.

<1	Less than 1
--	Not applicable
bgs	Below ground surface
CR	Cancer risk
E/C	Educational/cultural (industrial exposure scenario)
HI	Hazard index
IND	Industrial (industrial exposure scenario)
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
OS	Open space (recreational exposure scenario)
RME	Reasonable maximum exposure

TABLE 3-3: TOTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SUBSURFACE SOIL (0 TO 10 FEET BGS)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
DMI-1	MI	AX20	**2E-06**	<1	<1
DMI-1	MI	BA19	**6E-06**	<1	<1
DMI-1	MI	BA20	2E-08	<1	<1
DMI-1	MI	BA21	**3E-06**	<1	<1
DMI-1	MI	BA22	**2E-05**	<1	<1
DMI-1	MI	BA26	**2E-05**	<1	<1
DMI-1	MI	BB20	**2E-05**	<1	<1
DMI-1	MI	BB21	**2E-05**	<1	<1
DMI-1	MI	BB22	5E-08	<1	<1
DMI-1	MI	BB23	**1E-05**	<1	<1
DMI-1	MI	BB25	**3E-05**	<1	<1
DMI-1	MI	BB26	**1E-05**	<1	<1
DMI-1	MI	BC21	**1E-05**	<1	<1
DMI-1	MI	BC22	**2E-05**	<1	<1
DMI-1	MI	BC24	**1E-05**	<1	<1
DMI-1	MI	BC26	**3E-05**	<1	<1
DMI-1	MI	BC27	3E-08	<1	<1
DMI-1	MI	BD25	**2E-05**	<1	<1
DMI-1	MI	BD26	**8E-06**	<1	<1
DMI-1	MI	BD27	**1E-05**	<1	<1
DMI-1	MI	BD29	**6E-05**	<1	<1
DMI-1	MI	BE25	**2E-05**	<1	<1
DMI-1	MI	BE26	**2E-05**	<1	<1
DMI-1	MI	BE27	**1E-05**	<1	<1
DMI-1	MI	BE29	**1E-05**	<1	<1
DMI-1	MI	BF20	**9E-06**	<1	<1
DMI-1	MI	BF23	3E-08	<1	<1
DMI-1	MI	BG24	**9E-06**	<1	<1
DMI-1	MI	BG29	**9E-06**	<1	<1
DMI-1	MI	BG30	**1E-05**	<1	<1
DMI-1	MI	BG31	**2E-05**	<1	<1
DMI-1	MI	BH23	**1E-05**	<1	<1
DMI-1	MI	BH24	**1E-05**	<1	<1
DMI-1	MI	BH30	**2E-05**	<1	<1
DMI-1	MI	BH31	**2E-05**	<1	<1
DMI-1	MI	BI29	**1E-05**	<1	<1
DMI-1	MI	BI30	**2E-05**	<1	<1
DMI-1	MI	BI31	**1E-05**	<1	<1
DMI-1	MI	BJ30	**2E-05**	<1	<1
DMI-1	MI	BJ31	**2E-05**	<1	<1
DMI-1	MI	BJ32	4E-07	<1	<1
DMI-1	MI	BK31	**2E-06**	<1	<1
DMI-1	MI	BK32	3E-07	<1	<1
DMI-1	MI	BL24	**2E-05**	<1	<1
30B	IND	AR24	**7E-06**	<1	<1
30B	IND	AR25	**1E-05**	<1	<1
30B	IND	AS24	**4E-06**	<1	<1
30B	IND	AS25	9E-08	<1	<1
30B	IND	AT25	**2E-05**	<1	<1
37	IND	AT26	**1E-05**	<1	<1
37	IND	AT27	**3E-06**	<1	<1

TABLE 3-3: TOTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SUBSURFACE SOIL (0 TO 10 FEET BGS) (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
37	IND	AU26	**2E-05**	<1	<1
37	IND	AV26	**7E-06**	<1	<1
37	IND	AV28	**2E-05**	<1	<1
38	IND	AU24	**2E-05**	<1	<1
38	IND	AV25	**2E-05**	<1	<1
38	IND	AW23	**1E-05**	<1	<1
38	IND	AW24	**3E-06**	<1	<1
38	IND	AW25	**1E-05**	<1	<1
38	IND	AW26	**1E-05**	<1	<1
38	IND	AX24	**3E-06**	<1	<1
38	IND	AX25	**1E-05**	<1	<1
38	IND	AX27	6E-09	<1	<1
38	IND	AY26	**4E-05**	<1	<1
38	IND	AY27	**4E-06**	<1	<1
38	IND	AZ26	**1E-05**	<1	<1
42	IND	AY28	**2E-05**	<1	<1
42	IND	AZ27	**1E-05**	<1	<1
42	IND	AZ28	2E-10	<1	<1
42	IND	BA28	**2E-05**	<1	<1
42	IND	BA29	**8E-06**	<1	<1
42	IND	BB28	**9E-06**	<1	<1
42	IND	BB29	**2E-05**	<1	<1
29	E/C	AS20	**2E-05**	<1	<1
29	E/C	AS22	**7E-06**	<1	<1
29	E/C	AS23	**1E-05**	<1	<1
29	E/C	AT21	**8E-06**	<1	<1
29	E/C	AT22	**2E-05**	<1	<1
29	E/C	AT23	**1E-05**	<1	<1
29	E/C	AT24	**2E-05**	<1	<1
29	E/C	AU22	**1E-05**	<1	<1
29	E/C	AU23	**1E-05**	<1	<1
29	E/C	AV22	**8E-06**	<1	<1
30A	MU	062069	**9E-05**	6E+00	**4E+00**
30A	MU	064065	**3E-04**	1E+01	**6E+00**
30A	MU	066068	**9E-05**	7E+00	**3E+00**

Notes:	Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1.0 for segregated noncancer hazards.
<1	Less than 1
--	Not applicable
bgs	Below ground surface
E/C	Educational/cultural (industrial exposure scenario)
HI	Hazard index
IND	Industrial (industrial exposure scenario)
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
RB	Redevelopment block
RME	Reasonable maximum exposure
Seg	Segregated
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
RME	Reasonable maximum exposure

TABLE 3-4: TOTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
DMI-1	MI	AX20	4E-07	<1	<1
DMI-1	MI	BA19	1E-06	<1	<1
DMI-1	MI	BA20	9E-10	<1	<1
DMI-1	MI	BA21	5E-07	<1	<1
DMI-1	MI	BA22	**3E-06**	<1	<1
DMI-1	MI	BA26	**5E-06**	2E+00	<1
DMI-1	MI	BB20	**4E-06**	<1	<1
DMI-1	MI	BB21	**3E-06**	<1	<1
DMI-1	MI	BB22	2E-09	<1	<1
DMI-1	MI	BB23	**2E-06**	<1	<1
DMI-1	MI	BB25	**6E-06**	2E+00	<1
DMI-1	MI	BB26	**3E-06**	2E+00	<1
DMI-1	MI	BB29	**3E-06**	<1	<1
DMI-1	MI	BC21	**2E-06**	<1	<1
DMI-1	MI	BC22	**3E-06**	<1	<1
DMI-1	MI	BC24	**2E-06**	<1	<1
DMI-1	MI	BC26	**6E-06**	2E+00	<1
DMI-1	MI	BC27	1E-09	<1	<1
DMI-1	MI	BD25	**3E-06**	<1	<1
DMI-1	MI	BD26	1E-06	<1	<1
DMI-1	MI	BD27	**2E-06**	<1	<1
DMI-1	MI	BD29	**1E-05**	2E+00	<1
DMI-1	MI	BE25	**5E-06**	<1	<1
DMI-1	MI	BE26	**5E-06**	2E+00	<1
DMI-1	MI	BE27	**3E-06**	<1	<1
DMI-1	MI	BE29	**3E-06**	<1	<1
DMI-1	MI	BF20	**2E-06**	<1	<1
DMI-1	MI	BF23	4E-09	<1	<1
DMI-1	MI	BG24	**2E-06**	<1	<1
DMI-1	MI	BG29	**2E-06**	<1	<1
DMI-1	MI	BG30	**3E-06**	<1	<1
DMI-1	MI	BG31	**3E-06**	<1	<1
DMI-1	MI	BH23	**2E-06**	<1	<1
DMI-1	MI	BH24	**2E-06**	<1	<1
DMI-1	MI	BH30	**3E-06**	<1	<1
DMI-1	MI	BH31	**3E-06**	<1	<1
DMI-1	MI	BI29	**2E-06**	<1	<1
DMI-1	MI	BI30	**3E-06**	<1	<1
DMI-1	MI	BI31	**3E-06**	<1	<1
DMI-1	MI	BJ30	**4E-06**	<1	<1
DMI-1	MI	BJ31	**4E-06**	<1	<1
DMI-1	MI	BJ32	4E-08	<1	<1
DMI-1	MI	BK31	3E-07	<1	<1
DMI-1	MI	BK32	4E-08	<1	<1
DMI-1	MI	BL24	**4E-06**	<1	<1
30B	IND	AR24	1E-06	2E+00	<1
30B	IND	AR25	**3E-06**	<1	<1
30B	IND	AS24	8E-07	<1	<1
30B	IND	AS25	4E-09	<1	<1
30B	IND	AT25	**3E-06**	<1	<1
37	IND	AT26	**3E-06**	<1	<1
37	IND	AT27	6E-07	<1	<1

TABLE 3-4: TOTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
37	IND	AU26	**4E-06**	<1	<1
37	IND	AV26	1E-06	<1	<1
37	IND	AV28	**3E-06**	<1	<1
38	IND	AU24	**4E-06**	<1	<1
38	IND	AV25	**5E-06**	2E+00	<1
38	IND	AW23	**2E-06**	<1	<1
38	IND	AW24	6E-07	2E+00	<1
38	IND	AW25	**3E-06**	<1	<1
38	IND	AW26	**2E-06**	<1	<1
38	IND	AX24	5E-07	2E+00	<1
38	IND	AX25	**2E-06**	<1	<1
38	IND	AX27	2E-10	<1	<1
38	IND	AY26	**7E-06**	<1	<1
38	IND	AY27	8E-07	<1	<1
38	IND	AZ26	**2E-06**	<1	<1
42	IND	AY28	**3E-06**	<1	<1
42	IND	AZ27	**2E-06**	<1	<1
42	IND	AZ28	7E-12	<1	<1
42	IND	BA28	**3E-06**	2E+00	<1
42	IND	BA29	1E-06	2E+00	<1
42	IND	BB28	**2E-06**	<1	<1
29	E/C	AS20	**5E-06**	<1	<1
29	E/C	AS22	1E-06	2E+00	<1
29	E/C	AS23	**3E-06**	2E+00	<1
29	E/C	AT21	1E-06	<1	<1
29	E/C	AT22	**4E-06**	<1	<1
29	E/C	AT23	**2E-06**	<1	<1
29	E/C	AT24	**5E-06**	2E+00	<1
29	E/C	AU22	**3E-06**	<1	<1
29	E/C	AU23	**2E-06**	<1	<1
DOS-1	OS	AT19	**4E-06**	<1	<1
DOS-1	OS	AT20	**3E-06**	<1	<1
DOS-1	OS	AU19	**2E-06**	<1	<1
DOS-1	OS	AU20	**3E-06**	2E+00	<1
DOS-1	OS	AU21	6E-09	<1	<1
DOS-1	OS	AV19	9E-07	<1	<1
DOS-1	OS	AV20	**3E-06**	<1	<1
DOS-1	OS	AV21	1E-06	<1	<1
DOS-1	OS	AV22	1E-06	<1	<1
DOS-1	OS	AW20	1E-06	<1	<1
DOS-1	OS	AW21	**2E-06**	<1	<1
39	OS	AW22	8E-10	<1	<1
39	OS	AX21	9E-07	<1	<1
39	OS	AX22	7E-07	<1	<1
39	OS	AX23	7E-07	<1	<1
39	OS	AY23	**3E-06**	<1	<1
39	OS	AY24	5E-07	<1	<1
39	OS	AZ22	1E-09	2E+00	<1
39	OS	AZ24	1E-06	2E+00	<1
39	OS	AZ25	**3E-06**	<1	<1
39	OS	BA23	**3E-06**	<1	<1
39	OS	BA24	**2E-06**	2E+00	<1

TABLE 3-4: TOTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
39	OS	BA25	1E-06	<1	<1
30A	MU	AQ23	**5E-06**	<1	<1
30A	MU	AQ24	**2E-06**	<1	<1

Notes:	Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1.0 for segregated noncancer hazards.
<1	Less than 1
--	Not applicable
bgs	Below ground surface
E/C	Educational/cultural (industrial exposure scenario)
HI	Hazard index
IND	Industrial (industrial exposure scenario)
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
OS	Open space (recreational exposure scenario)
RME	Reasonable maximum exposure

TABLE 3-5: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SURFACE SOIL (0 TO 2 FEET BGS) BY PLANNED REUSE
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

													Percent Contribution by Exposure Pathway to Total RME Cancer Risk					Percent Contribution by Exposure Pathway to Total RME HI				Metals	
Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-Specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	HPAL	Maximum Concentration Exceeds HPAL?
DMI-1	MI	AX20	2.15E-06	<1	<1	Metal	Arsenic	C	0.92 - 0.92	9.20E-01	1/2	2.12E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BA19	6.02E-06	<1	<1	Metal	Arsenic	C	2.6 - 2.6	2.60E+00	1/1	6.00E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BA21	2.86E-06	<1	<1	Metal	Arsenic	C	0.7 - 0.98	9.80E-01	2/4	2.26E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BA22	2.16E-05	<1	<1	Metal	Arsenic	C	3.9 - 5.9	5.52E+00	4/5	1.27E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.057 - 1	1.00E+00	3/5	5.70E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
							Benzo(b)fluoranthene	C	0.094 - 2.2	2.20E+00	3/5	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BA26	3.13E-05	<1	<1	Metal	Arsenic	C	4.9 - 13.1	1.31E+01	3/3	3.02E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BB20	1.69E-05	<1	<1	Metal	Arsenic	C	5.7 - 7.3	7.30E+00	2/2	1.68E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BB21	2.13E-05	<1	<1	Metal	Arsenic	C	0.65 - 9	9.00E+00	3/3	2.08E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BB23	9.03E-06	<1	<1	Metal	Arsenic	C	2.4 - 3.9	3.90E+00	2/2	8.99E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BB25	2.87E-05	<1	<1	Metal	Arsenic	C	7.9 - 12.4	1.24E+01	2/2	2.86E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BB26	1.34E-05	<1	<1	Metal	Arsenic	C	2 - 5.7	5.70E+00	3/3	1.31E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BC21	9.70E-06	<1	<1	Metal	Arsenic	C	4.2 - 4.2	4.20E+00	1/1	9.68E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BC26	1.74E-05	<1	<1	Metal	Arsenic	C	1.6 - 9.5	6.91E+00	6/7	1.59E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BD25	1.64E-05	<1	<1	Metal	Arsenic	C	2.1 - 7.1	7.10E+00	3/3	1.64E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BD26	7.63E-06	<1	<1	Metal	Arsenic	C	3.3 - 3.3	3.30E+00	1/2	7.61E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BD27	1.02E-05	<1	<1	Metal	Arsenic	C	4.2 - 4.2	4.20E+00	1/1	9.68E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BD29	1.94E-05	<1	<1	Metal	Arsenic	C	8.4 - 8.4	8.40E+00	1/1	1.94E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BE25	2.50E-05	<1	<1	Metal	Arsenic	C	10.6 - 10.6	1.06E+01	1/1	2.44E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BE26	2.37E-05	<1	<1	Metal	Arsenic	C	3.7 - 8.6	8.60E+00	4/4	1.98E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.47 - 0.47	4.70E-01	1/3	2.68E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BE27	1.82E-05	<1	<1	Metal	Arsenic	C	2.4 - 7.9	7.90E+00	3/3	1.82E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BF20	8.76E-06	<1	<1	Metal	Arsenic	C	3.7 - 3.7	3.70E+00	1/1	8.53E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BG29	9.05E-06	<1	<1	Metal	Arsenic	C	3.9 - 3.9	3.90E+00	1/1	8.99E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BG30	1.67E-05	<1	<1	Metal	Arsenic	C	3.6 - 10.5	7.02E+00	15/16	1.62E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BG31	2.07E-05	<1	<1	Metal	Arsenic	C	1.6 - 11.1	6.68E+00	15/15	1.54E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.88 - 0.88	8.80E-01	1/11	5.01E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BH30	3.32E-05	<1	<1	Metal	Arsenic	C	4 - 13.9	1.39E+01	4/4	3.21E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BH31	1.66E-05	<1	<1	Metal	Arsenic	C	3.7 - 7.2	7.20E+00	2/2	1.66E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BI29	9.69E-06	<1	<1	Metal	Arsenic	C	4.2 - 4.2	4.20E+00	1/1	9.68E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BI30	1.52E-05	<1	<1	Metal	Arsenic	C	5.1 - 6.6	6.60E+00	2/2	1.52E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BI31	6.00E-06	<1	<1	Metal	Arsenic	C	2.6 - 2.6	2.60E+00	1/1	6.00E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BJ30	2.29E-05	<1	<1	Metal	Arsenic	C	3.8 - 11	8.64E+00	14/14	1.99E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.011 - 0.51	2.82E-01	8/14	1.60E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BJ31	3.17E-05	<1	<1	Metal	Arsenic	C	4.3 - 17	1.25E+01	8/8	2.88E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.017 - 0.35	3.50E-01	3/8	1.99E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BL24	2.55E-05	<1	<1	Metal	Arsenic	C	1.9 - 13.6	1.02E+01	9/9	2.35E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.22 - 0.22	2.20E-01	1/7	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
30B	IND	AR24	8.20E-06	<1	<1	Metal	Arsenic	C	3.2 - 3.5	3.50E+00	3/3	8.07E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
30B	IND	AR25	1.89E-05	<1	<1	Metal	Arsenic	C	3 - 11	8.18E+00	8/8	1.89E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
30B	IND	AT25	3.93E-06	<1	<1	Metal	Arsenic	C	1.7 - 1.7	1.70E+00	1/1	3.92E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No

TABLE 3-5: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SURFACE SOIL (0 TO 2 FEET BGS) BY PLANNED REUSE (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

													Percent Contribution by Exposure Pathway to Total RME Cancer Risk					Percent Contribution by Exposure Pathway to Total RME HI				Metals	
Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-Specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	HPAL	Maximum Concentration Exceeds HPAL?
37	IND	AT26	1.64E-05	<1	<1	Metal	Arsenic	C	1.9 - 7.1	7.10E+00	3/3	1.64E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AT27	3.01E-06	<1	<1	Metal	Arsenic	C	1.3 - 1.3	1.30E+00	1/1	3.00E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AU26	1.80E-05	<1	<1	Metal	Arsenic	C	7.8 - 7.8	7.80E+00	1/1	1.80E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AV28	2.30E-05	<1	<1	Metal	Arsenic	C	1 - 10.9	9.97E+00	4/4	2.30E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AU24	2.20E-05	<1	<1	Metal	Arsenic	C	1.7 - 9.5	9.50E+00	3/4	2.19E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AV25	6.85E-06	<1	<1	Metal	Arsenic	C	2.5 - 2.5	2.50E+00	2/2	5.76E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AW23	1.03E-05	<1	<1	Metal	Arsenic	C	4.4 - 4.4	4.40E+00	1/1	1.01E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AW25	1.22E-05	<1	<1	Metal	Arsenic	C	5.3 - 5.3	5.30E+00	1/1	1.22E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AY27	5.10E-06	<1	<1	Metal	Arsenic	C	1.9 - 2.2	2.20E+00	2/2	5.07E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AZ26	1.00E-05	<1	<1	Metal	Arsenic	C	2.3 - 4.3	4.30E+00	2/2	9.92E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	AY28	1.61E-05	<1	<1	Metal	Arsenic	C	7 - 7	7.00E+00	1/1	1.61E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BA28	6.56E-06	<1	<1	Metal	Arsenic	C	2.4 - 2.4	2.40E+00	1/1	5.53E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BA29	1.29E-05	<1	<1	Metal	Arsenic	C	2.8 - 5.3	5.30E+00	3/3	1.22E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BB28	9.27E-06	<1	<1	Metal	Arsenic	C	2.7 - 3.8	3.80E+00	2/2	8.76E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BB29	1.71E-05	<1	<1	Metal	Arsenic	C	7.3 - 7.3	7.30E+00	1/1	1.68E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AS20	2.47E-05	<1	<1	Metal	Arsenic	C	5.2 - 12.5	1.06E+01	5/6	2.44E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
29	E/C	AS22	6.94E-06	<1	<1	Metal	Arsenic	C	2.1 - 3	3.00E+00	2/2	6.92E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AS23	3.18E-05	<1	<1	Metal	Arsenic	C	0.4 - 15	1.34E+01	13/15	3.08E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
29	E/C	AT21	7.57E-06	<1	<1	Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/2	7.15E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AT22	2.27E-05	<1	<1	Metal	Arsenic	C	0.59 - 9.8	9.80E+00	3/3	2.26E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
							Lead	NC	7.7 - 920	9.20E+02	3/3	--	--	--	--		--	--	--	--		800	Yes
29	E/C	AT23	1.13E-05	<1	<1	Metal	Arsenic	C	1.1 - 6.5	4.85E+00	6/7	1.12E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AT24	3.14E-05	<1	<1	Metal	Arsenic	C	1.9 - 14.2	1.28E+01	4/4	2.96E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.3 - 0.3	3.00E-01	1/5	1.71E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
29	E/C	AU22	1.81E-05	<1	<1	Metal	Arsenic	C	3.5 - 7.8	7.80E+00	3/3	1.80E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AU23	1.03E-05	<1	<1	Metal	Arsenic	C	2 - 4.4	4.40E+00	3/4	1.01E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AV22	7.63E-06	<1	<1	Metal	Arsenic	C	3.3 - 3.3	3.30E+00	1/2	7.61E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DOS-1	OS	AT20	1.99E-05	<1	<1	Metal	Arsenic	C	0.68 - 10.7	6.23E+00	11/15	1.68E-05	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.021 - 0.24	2.40E-01	3/15	1.84E-06	28 %	71.9 %	0.0 %		--	--	--	--		--	--
DOS-1	OS	AU19	1.43E-05	<1	<1	Metal	Arsenic	C	3.2 - 5.3	5.30E+00	2/2	1.43E-05	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
DOS-1	OS	AU20	1.25E-05	<1	<1	Metal	Arsenic	C	1.3 - 6.2	4.62E+00	6/8	1.24E-05	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
DOS-1	OS	AV20	1.15E-05	<1	<1	Metal	Arsenic	C	2.7 - 2.7	2.70E+00	1/1	7.27E-06	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.49 - 0.49	4.90E-01	1/1	3.75E-06	28 %	71.9 %	0.0 %		--	--	--	--		--	--
DOS-1	OS	AV21	7.81E-06	<1	<1	Metal	Arsenic	C	2.9 - 2.9	2.90E+00	1/1	7.81E-06	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
DOS-1	OS	AW20	1.37E-05	<1	<1	Metal	Arsenic	C	1.8 - 3.7	3.70E+00	3/3	9.96E-06	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.27 - 0.27	2.70E-01	1/3	2.07E-06	28 %	71.9 %	0.0 %		--	--	--	--		--	--
DOS-1	OS	AW21	1.05E-05	<1	<1	Metal	Arsenic	C	0.33 - 4	3.89E+00	5/5	1.05E-05	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
39	OS	AX21	1.10E-05	<1	<1	Metal	Arsenic	C	0.34 - 4.1	4.10E+00	5/7	1.10E-05	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
39	OS	AX23	4.04E-06	<1	<1	Metal	Arsenic	C	1.5 - 1.5	1.50E+00	1/1	4.04E-06	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
39	OS	AY23	1.27E-04	<1	<1	Metal	Arsenic	C	0.45 - 47.2	4.72E+01	3/5	1.27E-04	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	Yes
39	OS	AY24	3.26E-06	<1	<1	Metal	Arsenic	C	1.2 - 1.2	1.20E+00	1/1	3.23E-06	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No

TABLE 3-5: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SURFACE SOIL (0 TO 2 FEET BGS) BY PLANNED REUSE (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

													Percent Contribution by Exposure Pathway to Total RME Cancer Risk					Percent Contribution by Exposure Pathway to Total RME HI				Metals	
Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-Specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	HPAL	Maximum Concentration Exceeds HPAL?
39	OS	BA23	1.64E-05	<1	<1	Metal	Arsenic	C	4.7 - 6.1	6.10E+00	2/3	1.64E-05	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
39	OS	BA24	1.02E-05	<1	<1	Metal	Arsenic	C	3.8 - 3.8	3.80E+00	1/1	1.02E-05	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
39	OS	BA25	4.42E-06	<1	<1	Metal	Arsenic	C	0.92 - 2	1.62E+00	4/5	4.35E-06	62.8 %	37.2 %	0.0 %		<1	--	--	--		11.1	No
30A	MU	066068	9.15E-05	2.67E+00	2.15E+00	Metal	Arsenic	C	3.5 - 3.5	3.50E+00	1/1	9.14E-05	56.6 %	5.4 %	0.0 %	38 %	<1	--	--	--	--	11.1	No
							Iron	NC	38,600 - 38,600	3.86E+04	1/1	--	--	--	--	--	1.76E+00	93.6 %	0.0 %	0.0 %	6.4 %	58000	No
							Manganese	NC	1,520 - 2,020	2.02E+03	2/2	--	--	--	--	--	2.40E+00	44.9 %	0.0 %	2.9 %	52.2 %	1431.18	Yes
							Vanadium	NC	94.4 - 94.4	9.44E+01	1/1	--	--	--	--	--	1.46E+00	82.9 %	0.0 %	0.0 %	17.1 %	117.17	No

Notes: All concentrations shown in mg/kg.

<1 Less than 1
-- Not applicable or chemical is not a chemical of concern for this endpoint
Not evaluated because exposure pathway is incomplete

bgs Below ground surface
C Cancer effect
E/C Educational/cultural (industrial exposure scenario)
EPC Exposure point concentration
HI Hazard index
HPAL Hunters Point ambient level
IND Industrial (industrial exposure scenario)
MI Maritime industrial (industrial exposure scenario)
MU Mixed use (residential exposure scenario)
NC Noncancer effect
OS Open space (recreational exposure scenario)
PAH Polynuclear aromatic hydrocarbon
RME Reasonable maximum exposure

TABLE 3-6: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SUBSURFACE SOIL (0 TO 10 FEET BGS) BY PLANNED REUSE

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Percent Contribution by Exposure Pathway to Total RME Cancer Risk: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-Specific HI	Percent Contribution by Exposure Pathway to Total RME HI: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Metals: HPAL	Maximum Concentration Exceeds HPAL?
DMI-1	MI	AX20	2.15E-06	<1	<1	Metal	Arsenic	C	0.63 - 0.92	9.20E-01	2/4	2.12E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BA19	6.02E-06	<1	<1	Metal	Arsenic	C	2.6 - 2.6	2.60E+00	1/1	6.00E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BA21	2.87E-06	<1	<1	Metal	Arsenic	C	0.7 - 0.98	9.80E-01	2/11	2.26E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BA22	1.87E-05	<1	<1	Metal	Arsenic	C	2 - 5.9	4.26E+00	11/12	9.82E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.057 - 1	1.00E+00	3/12	5.70E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
							Benzo(b)fluoranthene	C	0.094 - 2.2	2.20E+00	3/12	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BA26	2.44E-05	<1	<1	Metal	Arsenic	C	2.5 - 13.1	1.01E+01	4/5	2.33E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BB20	1.78E-05	<1	<1	Metal	Arsenic	C	1.5 - 9.8	7.71E+00	6/6	1.78E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BB21	1.62E-05	<1	<1	Metal	Arsenic	C	0.65 - 9.7	6.80E+00	9/9	1.57E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BB23	1.02E-05	<1	<1	Metal	Arsenic	C	2.4 - 3.9	3.90E+00	5/6	8.99E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BB25	2.87E-05	<1	<1	Metal	Arsenic	C	7.2 - 12.4	1.24E+01	3/3	2.86E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BB26	1.38E-05	<1	<1	Metal	Arsenic	C	0.62 - 6	5.89E+00	5/5	1.36E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BC21	9.74E-06	<1	<1	Metal	Arsenic	C	2.6 - 4.2	4.20E+00	2/3	9.68E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BC22	1.52E-05	<1	<1	Metal	Arsenic	C	4.4 - 6.6	6.60E+00	3/3	1.52E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BC24	1.11E-05	<1	<1	Metal	Arsenic	C	4.6 - 4.8	4.80E+00	2/4	1.11E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BC26	3.28E-05	<1	<1	Metal	Arsenic	C	1.6 - 25.3	1.36E+01	16/19	3.13E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BD25	1.64E-05	<1	<1	Metal	Arsenic	C	0.55 - 7.1	7.10E+00	4/6	1.64E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BD26	7.63E-06	<1	<1	Metal	Arsenic	C	0.5 - 3.3	3.30E+00	3/5	7.61E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BD27	1.02E-05	<1	<1	Metal	Arsenic	C	3.7 - 4.2	4.20E+00	2/2	9.68E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BD29	5.67E-05	<1	<1	Metal	Arsenic	C	8.4 - 22.3	2.23E+01	2/2	5.14E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.57 - 0.57	5.70E-01	1/1	3.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BE25	2.50E-05	<1	<1	Metal	Arsenic	C	2.8 - 10.6	1.06E+01	3/3	2.44E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BE26	2.46E-05	<1	<1	Metal	Arsenic	C	2.6 - 24.8	8.93E+00	13/13	2.06E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.47 - 0.47	4.70E-01	1/6	2.68E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BE27	1.43E-05	<1	<1	Metal	Arsenic	C	2.4 - 7.9	6.18E+00	6/6	1.42E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BE29	1.28E-05	<1	<1	Metal	Arsenic	C	5.5 - 5.5	5.50E+00	1/1	1.27E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BF20	9.06E-06	<1	<1	Metal	Arsenic	C	3.7 - 3.7	3.70E+00	1/2	8.53E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BG24	9.01E-06	<1	<1	Metal	Arsenic	C	2.1 - 3.9	3.90E+00	3/3	8.99E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BG29	9.07E-06	<1	<1	Metal	Arsenic	C	2.9 - 3.9	3.90E+00	3/3	8.99E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BG30	1.36E-05	<1	<1	Metal	Arsenic	C	2.6 - 16.6	5.66E+00	38/39	1.31E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BG31	1.89E-05	<1	<1	Metal	Arsenic	C	1.6 - 12	6.82E+00	29/29	1.57E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.017 - 0.88	4.33E-01	7/31	2.46E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BH23	1.03E-05	<1	<1	Metal	Arsenic	C	3.4 - 3.4	3.40E+00	1/3	7.84E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.32 - 0.32	3.20E-01	1/3	1.82E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BH24	1.04E-05	<1	<1	Metal	Arsenic	C	3.2 - 4.5	4.50E+00	3/7	1.04E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BH30	1.72E-05	<1	<1	Metal	Arsenic	C	3.1 - 13.9	6.94E+00	18/19	1.60E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
DMI-1	MI	BH31	1.66E-05	<1	<1	Metal	Arsenic	C	3.7 - 7.2	7.20E+00	2/3	1.66E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BI29	9.69E-06	<1	<1	Metal	Arsenic	C	3.5 - 4.2	4.20E+00	4/4	9.68E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BI30	1.53E-05	<1	<1	Metal	Arsenic	C	3.5 - 7.2	6.63E+00	8/8	1.53E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
DMI-1	MI	BI31	1.35E-05	<1	<1	Metal	Arsenic	C	2.3 - 10.5	5.71E+00	10/10	1.32E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No

TABLE 3-6: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SUBSURFACE SOIL (0 TO 10 FEET BGS) BY PLANNED REUSE (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Percent Contribution by Exposure Pathway to Total RME Cancer Risk: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-Specific HI	Percent Contribution by Exposure Pathway to Total RME HI: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Metals: HPAL	Maximum Concentration Exceeds HPAL?
DMI-1	MI	BJ30	1.93E-05	<1	<1	Metal	Arsenic	C	3.3 - 11	7.27E+00	25/25	1.68E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
						PAH	Benzo(a)pyrene	C	0.011 - 0.51	2.65E-01	8/25	1.51E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BJ31	2.33E-05	<1	<1	Metal	Arsenic	C	2.1 - 17	8.87E+00	19/19	2.05E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.017 - 0.35	3.50E-01	3/28	1.99E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BK31	2.39E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.015 - 0.28	2.80E-01	3/12	1.59E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
DMI-1	MI	BL24	2.10E-05	<1	<1	Metal	Arsenic	C	0.39 - 13.6	8.33E+00	19/30	1.92E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.22 - 0.22	2.20E-01	1/27	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
30B	IND	AR24	6.61E-06	<1	<1	Metal	Arsenic	C	1.6 - 3.5	2.70E+00	5/9	6.23E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
30B	IND	AR25	1.45E-05	<1	<1	Metal	Arsenic	C	0.64 - 11	6.24E+00	13/23	1.44E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
30B	IND	AS24	4.04E-06	<1	<1	Metal	Arsenic	C	1.3 - 1.7	1.70E+00	2/3	3.92E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
30B	IND	AT25	1.64E-05	<1	<1	Metal	Arsenic	C	1.7 - 7.1	7.10E+00	4/4	1.64E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AT26	1.49E-05	<1	<1	Metal	Arsenic	C	1.9 - 7.1	6.45E+00	5/6	1.49E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AT27	3.01E-06	<1	<1	Metal	Arsenic	C	1.3 - 1.3	1.30E+00	1/1	3.00E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AU26	1.80E-05	<1	<1	Metal	Arsenic	C	7.8 - 7.8	7.80E+00	1/2	1.80E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AV26	7.41E-06	<1	<1	Metal	Arsenic	C	3.2 - 3.2	3.20E+00	1/1	7.38E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
37	IND	AV28	1.60E-05	<1	<1	Metal	Arsenic	C	1 - 10.9	6.91E+00	7/8	1.59E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AU24	2.15E-05	<1	<1	Metal	Arsenic	C	1.3 - 9.5	9.27E+00	6/12	2.14E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AV25	2.40E-05	<1	<1	Metal	Arsenic	C	2.5 - 11.3	9.41E+00	7/8	2.17E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.13 - 0.19	1.90E-01	2/7	1.08E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
38	IND	AW23	1.03E-05	<1	<1	Metal	Arsenic	C	4.4 - 4.4	4.40E+00	1/1	1.01E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AW24	3.18E-06	<1	<1	Metal	Arsenic	C	1.3 - 1.3	1.30E+00	1/4	3.00E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AW25	1.33E-05	<1	<1	Metal	Arsenic	C	2.4 - 5.3	5.30E+00	2/2	1.22E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AW26	1.23E-05	<1	<1	Metal	Arsenic	C	2.2 - 5.3	5.30E+00	3/4	1.22E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AX24	2.58E-06	<1	<1	Metal	Arsenic	C	0.87 - 1.1	1.10E+00	2/3	2.54E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AX25	1.11E-05	<1	<1	Metal	Arsenic	C	1.6 - 4.8	4.80E+00	2/3	1.11E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AY26	3.51E-05	<1	<1	Metal	Arsenic	C	2 - 15.2	1.52E+01	4/4	3.50E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
38	IND	AY27	4.15E-06	<1	<1	Metal	Arsenic	C	1.5 - 2.2	1.79E+00	4/7	4.13E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
38	IND	AZ26	9.81E-06	<1	<1	Metal	Arsenic	C	1.1 - 4.6	3.84E+00	5/6	8.85E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	AY28	1.62E-05	<1	<1	Metal	Arsenic	C	7 - 7	7.00E+00	1/2	1.61E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	AZ27	1.11E-05	<1	<1	Metal	Arsenic	C	4.8 - 4.8	4.80E+00	1/1	1.11E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BA28	1.58E-05	<1	<1	Metal	Arsenic	C	1 - 6.4	6.40E+00	3/3	1.48E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BA29	7.62E-06	<1	<1	Metal	Arsenic	C	0.54 - 5.3	3.10E+00	11/11	7.15E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BB28	9.27E-06	<1	<1	Metal	Arsenic	C	2.7 - 3.8	3.80E+00	2/3	8.76E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
42	IND	BB29	1.71E-05	<1	<1	Metal	Arsenic	C	2.5 - 7.3	7.30E+00	3/3	1.68E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AS20	2.46E-05	<1	<1	Metal	Arsenic	C	5.2 - 12.5	1.06E+01	6/7	2.44E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
29	E/C	AS22	7.34E-06	<1	<1	Metal	Arsenic	C	0.47 - 3.4	3.11E+00	6/6	7.17E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AS23	1.36E-05	<1	<1	Metal	Arsenic	C	0.3025 - 15	5.42E+00	34/41	1.25E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
29	E/C	AT21	7.66E-06	<1	<1	Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/7	7.15E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AT22	2.28E-05	<1	<1	Metal	Arsenic	C	0.46 - 9.8	9.80E+00	7/9	2.26E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
							Lead	NC	2.1 - 920	9.20E+02	8/9	--	--	--	--		--	--	--	--		800	Yes
29	E/C	AT23	1.21E-05	<1	<1	Metal	Arsenic	C	0.38 - 6.5	5.18E+00	16/25	1.1951E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No

TABLE 3-6: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SUBSURFACE SOIL (0 TO 10 FEET BGS) BY PLANNED REUSE (CONTINUED)
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

													Percent Contribution by Exposure Pathway to Total RME Cancer Risk					Percent Contribution by Exposure Pathway to Total RME HI				Metals	
Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-Specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	HPAL	Maximum Concentration Exceeds HPAL?
29	E/C	AT24	2.38E-05	<1	<1	Metal	Arsenic	C	0.47 - 14.2	9.47E+00	12/14	2.18E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	Yes
						PAH	Benzo(a)pyrene	C	0.3 - 0.3	3.00E-01	1/15	1.71E-06	36.8 %	63.2 %	0.0 %		--	--	--	--		--	--
29	E/C	AU22	1.47E-05	<1	<1	Metal	Arsenic	C	2.3 - 7.8	6.33E+00	7/13	1.46E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AU23	1.24E-05	<1	<1	Metal	Arsenic	C	2 - 7.3	5.15E+00	9/10	1.19E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
29	E/C	AV22	7.63E-06	<1	<1	Metal	Arsenic	C	1.4 - 3.3	3.30E+00	4/10	7.61E-06	71.6 %	28.4 %	0.0 %		<1	--	--	--		11.1	No
30A	MU	062069	9.44E-05	6.24E+00	4.00E+00	Metal	Arsenic	C	1 - 3.6	3.60E+00	2/2	9.40E-05	56.6 %	5.4 %	0.0 %	38.0 %	<1	--	--	--	--	11.1	No
							Nickel	NC	45.6 - 1,220	1.22E+03	2/2	1.25E-07	--	--	--	--	4.00E+00	19.3 %	0.0 %	1.0 %	79.6 %	*	Yes
30A	MU	064065	2.72E-04	9.72E+00	4.62E+00	Metal	Arsenic	C	10.4 - 10.4	1.04E+01	1/1	2.72E-04	56.6 %	5.4 %	0.0 %	38.0 %	<1	--	--	--	--	11.1	No
							Manganese	NC	4,830 - 4,830	4.83E+03	1/1	--	--	--	--	--	4.47E+00	44.9 %	0.0 %	2.9 %	52.2 %	1431.18	Yes
							Nickel	NC	501 - 501	5.01E+02	1/1	5.15E-08	--	--	--	--	1.64E+00	19.3 %	0.0 %	1.0 %	79.6 %	*	Yes
30A	MU	066068	9.15E-05	7.47E+00	2.15E+00	Metal	Arsenic	C	3.5 - 3.5	3.50E+00	1/1	9.14E-05	56.6 %	5.4 %	0.0 %	38.0 %	<1	--	--	--	--	11.1	No
							Iron	NC	38,600 - 38,600	3.86E+04	1/1	--	--	--	--	--	1.76E+00	93.6 %	0.0 %	0.0 %	6.4 %	58000	No
							Manganese	NC	1,520 - 2,020	2.02E+03	2/2	--	--	--	--	--	1.87E+00	44.9 %	0.0 %	2.9 %	52.2 %	1431.18	Yes
							Vanadium	NC	94.4 - 94.4	9.44E+01	1/1	--	--	--	--	--	1.46E+00	82.9 %	0.0 %	0.0 %	17.1 %	117.17	No

Notes: All concentrations shown in mg/kg.

<1 Less than 1

-- Not applicable or chemical is not a chemical of concern for this endpoint

* Not available; comparison to ambient levels based on regression analysis

[shaded] Not evaluated because exposure pathway is incomplete

bgs	Below ground surface
C	Cancer effect
E/C	Educational/cultural (industrial exposure scenario)
EPC	Exposure point concentration
HI	Hazard index
HPAL	Hunters Point ambient level
HPS	Hunters Point Shipyard
IND	Industrial (industrial exposure scenario)
mg/kg	Milligrams per kilogram
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
NC	Noncancer effect
PAH	Polynuclear aromatic hydrocarbon
PRG	Preliminary remediation goal
OS	Open space (recreational exposure scenario)
RME	Reasonable maximum exposure

TABLE 3-7: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SUBSURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-Specific HI	Metals	
														HPAL	Maximum Concentration Exceeds HPAL?
DMI-1	MI	BA19	1.61E-06	1.05E+00	<1	Metal	Arsenic	C	2.6 - 2.6	2.60E+00	1/1	1.60E-06	<1	11.1	No
DMI-1	MI	BA22	5.02E-06	1.67E+00	<1	Metal	Arsenic	C	2 - 5.9	4.26E+00	11/12	2.63E-06	<1	11.1	No
						PAH	Benzo(a)pyrene	C	0.057 - 1	1.00E+00	3/12	1.55E-06	--	--	--
DMI-1	MI	BA26	6.51E-06	1.98E+00	<1	Metal	Arsenic	C	2.5 - 13.1	1.01E+01	4/5	6.23E-06	<1	11.1	Yes
DMI-1	MI	BB20	4.76E-06	1.11E+00	<1	Metal	Arsenic	C	1.5 - 9.8	7.71E+00	6/6	4.76E-06	<1	11.1	No
DMI-1	MI	BB21	4.32E-06	1.31E+00	<1	Metal	Arsenic	C	0.65 - 9.7	6.80E+00	9/9	4.19E-06	<1	11.1	No
DMI-1	MI	BB23	2.73E-06	1.29E+00	<1	Metal	Arsenic	C	2.4 - 3.9	3.90E+00	5/6	2.40E-06	<1	11.1	No
DMI-1	MI	BB25	7.67E-06	1.80E+00	<1	Metal	Arsenic	C	7.2 - 12.4	1.24E+01	3/3	7.65E-06	<1	11.1	Yes
DMI-1	MI	BB26	3.68E-06	1.60E+00	<1	Metal	Arsenic	C	0.62 - 6	5.89E+00	5/5	3.63E-06	<1	11.1	No
DMI-1	MI	BC21	2.60E-06	<1	<1	Metal	Arsenic	C	2.6 - 4.2	4.20E+00	2/3	2.59E-06	<1	11.1	No
DMI-1	MI	BC22	4.07E-06	1.04E+00	<1	Metal	Arsenic	C	4.4 - 6.6	6.60E+00	3/3	4.07E-06	<1	11.1	No
DMI-1	MI	BC24	2.96E-06	1.10E+00	<1	Metal	Arsenic	C	4.6 - 4.8	4.80E+00	2/4	2.96E-06	<1	11.1	No
DMI-1	MI	BC26	8.70E-06	2.07E+00	<1	Metal	Arsenic	C	1.6 - 25.3	1.36E+01	16/19	8.37E-06	<1	11.1	Yes
DMI-1	MI	BD25	4.38E-06	1.37E+00	<1	Metal	Arsenic	C	0.55 - 7.1	7.10E+00	4/6	4.38E-06	<1	11.1	No
DMI-1	MI	BD26	2.04E-06	1.24E+00	<1	Metal	Arsenic	C	0.5 - 3.3	3.30E+00	3/5	2.03E-06	<1	11.1	No
DMI-1	MI	BD27	2.72E-06	<1	<1	Metal	Arsenic	C	3.7 - 4.2	4.20E+00	2/2	2.59E-06	<1	11.1	No
DMI-1	MI	BD29	1.51E-05	1.69E+00	<1	Metal	Arsenic	C	8.4 - 22.3	2.23E+01	2/2	1.38E-05	<1	11.1	Yes
DMI-1	MI	BE25	6.68E-06	1.28E+00	<1	Metal	Arsenic	C	2.8 - 10.6	1.06E+01	3/3	6.54E-06	<1	11.1	No
DMI-1	MI	BE26	6.58E-06	2.53E+00	1.41E+00	Metal	Arsenic	C	2.6 - 24.8	8.93E+00	13/13	5.50E-06	<1	11.1	Yes
							Manganese	NC	99.4 - 9,270	9.27E+03	9/9	--	1.35E+00	1431.18	Yes
DMI-1	MI	BE27	3.81E-06	1.40E+00	<1	Metal	Arsenic	C	2.4 - 7.9	6.18E+00	6/6	3.81E-06	<1	11.1	No
DMI-1	MI	BE29	3.40E-06	1.34E+00	<1	Metal	Arsenic	C	5.5 - 5.5	5.50E+00	1/1	3.39E-06	<1	11.1	No
DMI-1	MI	BF20	2.42E-06	<1	<1	Metal	Arsenic	C	3.7 - 3.7	3.70E+00	1/2	2.28E-06	<1	11.1	No
DMI-1	MI	BG24	2.41E-06	<1	<1	Metal	Arsenic	C	2.1 - 3.9	3.90E+00	3/3	2.40E-06	<1	11.1	No
DMI-1	MI	BG29	2.42E-06	<1	<1	Metal	Arsenic	C	2.9 - 3.9	3.90E+00	3/3	2.40E-06	<1	11.1	No
DMI-1	MI	BG30	3.59E-06	<1	<1	Metal	Arsenic	C	2.6 - 16.6	5.66E+00	38/39	3.49E-06	<1	11.1	Yes
DMI-1	MI	BG31	5.06E-06	1.51E+00	<1	Metal	Arsenic	C	1.6 - 12	6.82E+00	29/29	4.21E-06	<1	11.1	Yes
DMI-1	MI	BH23	2.76E-06	1.06E+00	<1	Metal	Arsenic	C	3.4 - 3.4	3.40E+00	1/3	2.10E-06	<1	11.1	No
DMI-1	MI	BH24	2.78E-06	1.19E+00	<1	Metal	Arsenic	C	3.2 - 4.5	4.50E+00	3/7	2.77E-06	<1	11.1	No
DMI-1	MI	BH30	4.59E-06	1.27E+00	<1	Metal	Arsenic	C	3.1 - 13.9	6.94E+00	18/19	4.28E-06	<1	11.1	Yes
DMI-1	MI	BH31	4.44E-06	1.39E+00	<1	Metal	Arsenic	C	3.7 - 7.2	7.20E+00	2/3	4.44E-06	<1	11.1	No
DMI-1	MI	BI29	2.59E-06	<1	<1	Metal	Arsenic	C	3.5 - 4.2	4.20E+00	4/4	2.59E-06	<1	11.1	No
DMI-1	MI	BI30	4.09E-06	<1	<1	Metal	Arsenic	C	3.5 - 7.2	6.63E+00	8/8	4.09E-06	<1	11.1	No
DMI-1	MI	BI31	3.60E-06	<1	<1	Metal	Arsenic	C	2.3 - 10.5	5.71E+00	10/10	3.52E-06	<1	11.1	No

Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-Specific HI	Metals	
														HPAL	Maximum Concentration Exceeds HPAL?
DMI-1	MI	BJ30	5.17E-06	1.06E+00	<1	Metal	Arsenic	C	3.3 - 11	7.27E+00	25/25	4.48E-06	<1	11.1	No
DMI-1	MI	BJ31	6.24E-06	<1	<1	Metal	Arsenic	C	2.1 - 17	8.87E+00	19/19	5.47E-06	<1	11.1	Yes
DMI-1	MI	BL24	5.61E-06	1.14E+00	<1	Metal	Arsenic	C	0.39 - 13.6	8.33E+00	19/30	5.13E-06	<1	11.1	Yes
30B	IND	AR24	1.72E-06	1.71E+00	<1	Metal	Arsenic	C	1.6 - 3.5	2.70E+00	5/9	1.67E-06	<1	11.1	No
30B	IND	AR25	3.85E-06	1.43E+00	<1	Metal	Arsenic	C	0.64 - 11	6.24E+00	13/23	3.85E-06	<1	11.1	No
30B	IND	AS24	1.05E-06	1.03E+00	<1	Metal	Arsenic	C	1.3 - 1.7	1.70E+00	2/3	1.05E-06	<1	11.1	No
30B	IND	AT25	4.38E-06	1.17E+00	<1	Metal	Arsenic	C	1.7 - 7.1	7.10E+00	4/4	4.38E-06	<1	11.1	No
37	IND	AT26	3.98E-06	1.13E+00	<1	Metal	Arsenic	C	1.9 - 7.1	6.45E+00	5/6	3.98E-06	<1	11.1	No
37	IND	AU26	4.81E-06	1.27E+00	<1	Metal	Arsenic	C	7.8 - 7.8	7.80E+00	1/2	4.81E-06	<1	11.1	No
37	IND	AV26	1.97E-06	<1	<1	Metal	Arsenic	C	3.2 - 3.2	3.20E+00	1/1	1.97E-06	<1	11.1	No
37	IND	AV28	4.27E-06	1.44E+00	<1	Metal	Arsenic	C	1 - 10.9	6.91E+00	7/8	4.26E-06	<1	11.1	No
38	IND	AU24	5.73E-06	1.53E+00	<1	Metal	Arsenic	C	1.3 - 9.5	9.27E+00	6/12	5.72E-06	<1	11.1	No
38	IND	AV25	6.42E-06	1.86E+00	<1	Metal	Arsenic	C	2.5 - 11.3	9.41E+00	7/8	5.80E-06	<1	11.1	Yes
38	IND	AW23	2.74E-06	<1	<1	Metal	Arsenic	C	4.4 - 4.4	4.40E+00	1/1	2.71E-06	<1	11.1	No
38	IND	AW25	3.56E-06	1.08E+00	<1	Metal	Arsenic	C	2.4 - 5.3	5.30E+00	2/2	3.27E-06	<1	11.1	No
38	IND	AW26	3.27E-06	1.36E+00	<1	Metal	Arsenic	C	2.2 - 5.3	5.30E+00	3/4	3.27E-06	<1	11.1	No
38	IND	AX25	2.96E-06	1.43E+00	<1	Metal	Arsenic	C	1.6 - 4.8	4.80E+00	2/3	2.96E-06	<1	11.1	No
38	IND	AY26	9.38E-06	1.20E+00	<1	Metal	Arsenic	C	2 - 15.2	1.52E+01	4/4	9.37E-06	<1	11.1	Yes
38	IND	AY27	1.10E-06	1.34E+00	<1	Metal	Arsenic	C	1.5 - 2.2	1.79E+00	4/7	1.10E-06	<1	11.1	No
38	IND	AZ26	2.60E-06	1.47E+00	<1	Metal	Arsenic	C	1.1 - 4.6	3.84E+00	5/6	2.37E-06	<1	11.1	No
42	IND	AY28	4.32E-06	<1	<1	Metal	Arsenic	C	7 - 7	7.00E+00	1/2	4.32E-06	<1	11.1	No
42	IND	AZ27	2.97E-06	1.01E+00	<1	Metal	Arsenic	C	4.8 - 4.8	4.80E+00	1/1	2.96E-06	<1	11.1	No
42	IND	BA28	4.21E-06	1.96E+00	<1	Metal	Arsenic	C	1 - 6.4	6.40E+00	3/3	3.95E-06	<1	11.1	No
42	IND	BA29	2.00E-06	1.66E+00	<1	Metal	Arsenic	C	0.54 - 5.3	3.10E+00	11/11	1.91E-06	<1	11.1	No
42	IND	BB28	2.47E-06	1.57E+00	<1	Metal	Arsenic	C	2.7 - 3.8	3.80E+00	2/3	2.34E-06	<1	11.1	No
42	IND	BB29	4.57E-06	<1	<1	Metal	Arsenic	C	2.5 - 7.3	7.30E+00	3/3	4.50E-06	<1	11.1	No
29	E/C	AS20	6.59E-06	<1	<1	Metal	Arsenic	C	5.2 - 12.5	1.06E+01	6/7	6.53E-06	<1	11.1	Yes
29	E/C	AS22	1.92E-06	1.79E+00	<1	Metal	Arsenic	C	0.47 - 3.4	3.11E+00	6/6	1.92E-06	<1	11.1	No
29	E/C	AS23	3.58E-06	1.64E+00	<1	Metal	Arsenic	C	0.3025 - 15	5.42E+00	34/41	3.34E-06	<1	11.1	Yes
29	E/C	AT21	1.94E-06	1.24E+00	<1	Metal	Arsenic	C	3.1 - 3.1	3.10E+00	1/7	1.91E-06	<1	11.1	No
29	E/C	AT22	6.06E-06	1.32E+00	<1	Metal	Arsenic	C	0.46 - 9.8	9.80E+00	7/9	6.04E-06	<1	11.1	No
							Lead	NC	2.1 - 920	9.20E+02	8/9	--	--	800	Yes
29	E/C	AT23	3.20E-06	1.48E+00	<1	Metal	Arsenic	C	0.38 - 6.5	5.18E+00	16/25	3.20E-06	<1	11.1	No
29	E/C	AT24	6.33E-06	1.77E+00	<1	Metal	Arsenic	C	0.47 - 14.2	9.47E+00	12/14	5.84E-06	<1	11.1	Yes

TABLE 3-7: TOTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SUBSURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-Specific HI	Metals	
														HPAL	Maximum Concentration Exceeds HPAL?
29	E/C	AU22	3.91E-06	1.37E+00	<1	Metal	Arsenic	C	2.3 - 7.8	6.33E+00	7/13	3.90E-06	<1	11.1	No
29	E/C	AU23	3.30E-06	1.29E+00	<1	Metal	Arsenic	C	2 - 7.3	5.15E+00	9/10	3.17E-06	<1	11.1	No
29	E/C	AV22	2.04E-06	1.43E+00	<1	Metal	Arsenic	C	1.4 - 3.3	3.30E+00	4/10	2.03E-06	<1	11.1	No
DOS-1	OS	AT19	5.39E-06	1.37E+00	<1	Metal	Arsenic	C	1.4 - 8.7	8.70E+00	4/8	5.36E-06	<1	11.1	No
DOS-1	OS	AT20	4.18E-06	1.49E+00	<1	Metal	Arsenic	C	0.68 - 10.7	5.77E+00	12/18	3.56E-06	<1	11.1	No
DOS-1	OS	AU19	2.78E-06	1.34E+00	<1	Metal	Arsenic	C	2.5 - 6.7	4.39E+00	5/8	2.71E-06	<1	11.1	No
DOS-1	OS	AU20	4.58E-06	1.71E+00	<1	Metal	Arsenic	C	0.55 - 24	7.32E+00	20/24	4.51E-06	<1	11.1	Yes
DOS-1	OS	AV19	1.23E-06	<1	<1	Metal	Arsenic	C	2 - 2	2.00E+00	1/1	1.23E-06	<1	11.1	No
DOS-1	OS	AV20	4.29E-06	1.46E+00	<1	Metal	Arsenic	C	2.3 - 6.1	5.33E+00	5/5	3.29E-06	<1	11.1	No
DOS-1	OS	AV21	1.92E-06	1.49E+00	<1	Metal	Arsenic	C	1.5 - 3.5	3.12E+00	5/5	1.92E-06	<1	11.1	No
DOS-1	OS	AW20	2.33E-06	1.32E+00	<1	Metal	Arsenic	C	0.85 - 3.7	2.55E+00	7/8	1.57E-06	<1	11.1	No
DOS-1	OS	AW21	3.32E-06	1.42E+00	<1	Metal	Arsenic	C	0.33 - 6.3	5.38E+00	13/16	3.32E-06	<1	11.1	No
39	OS	AX21	1.18E-06	1.30E+00	<1	Metal	Arsenic	C	0.34 - 4.1	1.91E+00	8/14	1.18E-06	<1	11.1	No
39	OS	AY23	4.59E-06	1.36E+00	<1	Metal	Arsenic	C	0.45 - 47.2	7.32E+00	13/20	4.51E-06	<1	11.1	Yes
39	OS	AZ24	1.86E-06	1.88E+00	<1	Metal	Arsenic	C	0.72 - 3	3.00E+00	2/5	1.85E-06	<1	11.1	No
39	OS	AZ25	3.52E-06	1.12E+00	<1	Metal	Arsenic	C	0.48 - 8.6	5.59E+00	8/17	3.45E-06	<1	11.1	No
39	OS	BA23	3.76E-06	1.26E+00	<1	Metal	Arsenic	C	1.2 - 6.1	6.10E+00	5/8	3.76E-06	<1	11.1	No
39	OS	BA24	2.35E-06	1.61E+00	<1	Metal	Arsenic	C	0.66 - 3.8	3.80E+00	3/3	2.34E-06	<1	11.1	No
39	OS	BA25	1.34E-06	1.29E+00	<1	Metal	Arsenic	C	0.77 - 4.4	2.14E+00	10/11	1.32E-06	<1	11.1	No
30A	MU	AQ23	6.42E-06	1.06E+00	<1	Metal	Arsenic	C	10.4 - 10.4	1.04E+01	1/1	6.41E-06	<1	11.1	No
30A	MU	AQ24	2.23E-06	<1	<1	Metal	Arsenic	C	1 - 3.6	3.60E+00	2/2	2.22E-06	<1	11.1	No

Notes: All concentrations shown in mg/kg.

<1 Less than 1

– Not applicable or chemical is not a chemical of concern for this endpoint

bgs Below ground surface
C Cancer effect
E/C Educational/cultural (industrial exposure scenario)
EPC Exposure point concentration
HI Hazard index
HPAL Hunters Point ambient level
IND Industrial (industrial exposure scenario)
mg/kg Milligrams per kilogram
MI Maritime industrial (industrial exposure scenario)
MU Mixed use (residential exposure scenario)
NC Noncancer effect
PAH Polynuclear aromatic hydrocarbon
OS Open space (recreational exposure scenario)
RME Reasonable maximum exposure

TABLE 3-8: INCREMENTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 2 FEET BGS)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
DMI-1	MI	AX20	4E-09	<1	<1
DMI-1	MI	BA19	4E-09	<1	<1
DMI-1	MI	BA20	--	<1	<1
DMI-1	MI	BA21	6E-07	<1	<1
DMI-1	MI	BA22	**9E-06**	<1	<1
DMI-1	MI	BA26	**3E-05**	<1	<1
DMI-1	MI	BB20	--	<1	<1
DMI-1	MI	BB21	5E-07	<1	<1
DMI-1	MI	BB22	2E-08	<1	<1
DMI-1	MI	BB23	--	<1	<1
DMI-1	MI	BB25	**3E-05**	<1	<1
DMI-1	MI	BB26	2E-07	<1	<1
DMI-1	MI	BC21	--	<1	<1
DMI-1	MI	BC26	1E-06	<1	<1
DMI-1	MI	BC27	--	<1	<1
DMI-1	MI	BD25	4E-10	<1	<1
DMI-1	MI	BD26	--	<1	<1
DMI-1	MI	BD27	5E-07	<1	<1
DMI-1	MI	BD29	4E-10	<1	<1
DMI-1	MI	BE25	5E-07	<1	<1
DMI-1	MI	BE26	**4E-06**	<1	<1
DMI-1	MI	BE27	--	<1	<1
DMI-1	MI	BF20	2E-07	<1	<1
DMI-1	MI	BF23	3E-08	<1	<1
DMI-1	MI	BG29	5E-08	<1	<1
DMI-1	MI	BG30	5E-07	<1	<1
DMI-1	MI	BG31	**5E-06**	<1	<1
DMI-1	MI	BH30	**3E-05**	<1	<1
DMI-1	MI	BH31	3E-09	<1	<1
DMI-1	MI	BI29	--	<1	<1
DMI-1	MI	BI30	--	<1	<1
DMI-1	MI	BI31	--	<1	<1
DMI-1	MI	BJ30	**3E-06**	<1	<1
DMI-1	MI	BJ31	**3E-05**	<1	<1
DMI-1	MI	BL24	**3E-05**	<1	<1
30B	IND	AR24	3E-08	<1	<1
30B	IND	AR25	1E-08	<1	<1
30B	IND	AS24	--	<1	<1
30B	IND	AS25	--	<1	<1
30B	IND	AT25	--	<1	<1
37	IND	AT26	--	<1	<1
37	IND	AT27	2E-09	<1	<1
37	IND	AU26	--	<1	<1
37	IND	AV28	--	<1	<1
38	IND	AU24	1E-08	<1	<1
38	IND	AV25	1E-06	<1	<1
38	IND	AW23	1E-07	<1	<1
38	IND	AW24	--	<1	<1
38	IND	AW25	4E-09	<1	<1
38	IND	AX27	--	<1	<1
38	IND	AY27	--	<1	<1
38	IND	AZ26	1E-07	<1	<1
42	IND	AY28	--	<1	<1

TABLE 3-8: INCREMENTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 2 FEET BGS) (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
42	IND	BA28	1E-06	<1	<1
42	IND	BA29	6E-07	<1	<1
42	IND	BB28	5E-07	<1	<1
42	IND	BB29	3E-07	<1	<1
29	E/C	AS20	**2E-05**	<1	<1
29	E/C	AS22	2E-08	<1	<1
29	E/C	AS23	**3E-05**	<1	<1
29	E/C	AT21	4E-07	<1	<1
29	E/C	AT22	2E-08	<1	<1
29	E/C	AT23	1E-08	<1	<1
29	E/C	AT24	**3E-05**	<1	<1
29	E/C	AU22	7E-08	<1	<1
29	E/C	AU23	6E-08	<1	<1
29	E/C	AV22	--	<1	<1
DOS-1	OS	AT19	--	<1	<1
DOS-1	OS	AT20	**3E-06**	<1	<1
DOS-1	OS	AU19	1E-08	<1	<1
DOS-1	OS	AU20	2E-08	<1	<1
DOS-1	OS	AU21	--	<1	<1
DOS-1	OS	AV20	**4E-06**	<1	<1
DOS-1	OS	AV21	--	<1	<1
DOS-1	OS	AW20	**4E-06**	<1	<1
DOS-1	OS	AW21	--	<1	<1
39	OS	AW22	--	<1	<1
39	OS	AX21	5E-10	<1	<1
39	OS	AX23	--	<1	<1
39	OS	AY23	**1E-04**	<1	<1
39	OS	AY24	3E-08	<1	<1
39	OS	AZ24	--	<1	<1
39	OS	AZ25	3E-07	<1	<1
39	OS	BA23	1E-09	<1	<1
39	OS	BA24	4E-10	<1	<1
39	OS	BA25	7E-08	<1	<1
30A	MU	066068	--	3E+00	**3E+00**

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1.0 for segregated noncancer hazards.

<1	Less than 1
--	Not applicable
bgs	Below ground surface
E/C	Educational/cultural (industrial exposure scenario)
HI	Hazard index
IND	Industrial (industrial exposure scenario)
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
OS	Open space (recreational exposure scenario)
RME	Reasonable maximum exposure

TABLE 3-9: INCREMENTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SUBSURFACE SOIL (0 TO 10 FEET BGS)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
DMI-1	MI	AX20	4E-09	<1	<1
DMI-1	MI	BA19	4E-09	<1	<1
DMI-1	MI	BA20	--	<1	<1
DMI-1	MI	BA21	6E-07	<1	<1
DMI-1	MI	BA22	**9E-06**	<1	<1
DMI-1	MI	BA26	**2E-05**	<1	<1
DMI-1	MI	BB20	9E-09	<1	<1
DMI-1	MI	BB21	5E-07	<1	<1
DMI-1	MI	BB22	4E-08	<1	<1
DMI-1	MI	BB23	1E-06	<1	<1
DMI-1	MI	BB25	**3E-05**	<1	<1
DMI-1	MI	BB26	2E-07	<1	<1
DMI-1	MI	BC21	4E-08	<1	<1
DMI-1	MI	BC22	--	<1	<1
DMI-1	MI	BC24	--	<1	<1
DMI-1	MI	BC26	**3E-05**	<1	<1
DMI-1	MI	BC27	--	<1	<1
DMI-1	MI	BD25	4E-10	<1	<1
DMI-1	MI	BD26	--	<1	<1
DMI-1	MI	BD27	5E-07	<1	<1
DMI-1	MI	BD29	**6E-05**	<1	<1
DMI-1	MI	BE25	5E-07	<1	<1
DMI-1	MI	BE26	**2E-05**	<1	<1
DMI-1	MI	BE27	--	<1	<1
DMI-1	MI	BE29	3E-08	<1	<1
DMI-1	MI	BF20	5E-07	<1	<1
DMI-1	MI	BF23	3E-08	<1	<1
DMI-1	MI	BG24	--	<1	<1
DMI-1	MI	BG29	7E-08	<1	<1
DMI-1	MI	BG30	**1E-05**	<1	<1
DMI-1	MI	BG31	**2E-05**	<1	<1
DMI-1	MI	BH23	**2E-06**	<1	<1
DMI-1	MI	BH24	--	<1	<1
DMI-1	MI	BH30	**2E-05**	<1	<1
DMI-1	MI	BH31	3E-09	<1	<1
DMI-1	MI	BI29	--	<1	<1
DMI-1	MI	BI30	2E-10	<1	<1
DMI-1	MI	BI31	3E-07	<1	<1
DMI-1	MI	BJ30	**3E-06**	<1	<1
DMI-1	MI	BJ31	**2E-05**	<1	<1
DMI-1	MI	BJ32	4E-07	<1	<1
DMI-1	MI	BK31	**2E-06**	<1	<1
DMI-1	MI	BK32	3E-07	<1	<1
DMI-1	MI	BL24	**2E-05**	<1	<1
30B	IND	AR24	2E-07	<1	<1
30B	IND	AR25	1E-08	<1	<1
30B	IND	AS24	--	<1	<1
30B	IND	AS25	--	<1	<1
30B	IND	AT25	3E-08	<1	<1
37	IND	AT26	--	<1	<1
37	IND	AT27	2E-09	<1	<1

TABLE 3-9: INCREMENTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SUBSURFACE SOIL (0 TO 10 FEET BGS) (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
37	IND	AU26	--	<1	<1
37	IND	AV26	--	<1	<1
37	IND	AV28	4E-08	<1	<1
38	IND	AU24	5E-08	<1	<1
38	IND	AV25	**2E-05**	<1	<1
38	IND	AW23	1E-07	<1	<1
38	IND	AW24	7E-08	<1	<1
38	IND	AW25	1E-06	<1	<1
38	IND	AW26	3E-10	<1	<1
38	IND	AX24	5E-09	<1	<1
38	IND	AX25	--	<1	<1
38	IND	AX27	--	<1	<1
38	IND	AY26	**4E-05**	<1	<1
38	IND	AY27	--	<1	<1
38	IND	AZ26	9E-07	<1	<1
42	IND	AY28	--	<1	<1
42	IND	AZ27	5E-08	<1	<1
42	IND	AZ28	2E-10	<1	<1
42	IND	BA28	1E-06	<1	<1
42	IND	BA29	3E-07	<1	<1
42	IND	BB28	5E-07	<1	<1
42	IND	BB29	3E-07	<1	<1
29	E/C	AS20	**2E-05**	<1	<1
29	E/C	AS22	6E-08	<1	<1
29	E/C	AS23	**1E-05**	<1	<1
29	E/C	AT21	4E-07	<1	<1
29	E/C	AT22	6E-08	<1	<1
29	E/C	AT23	1E-07	<1	<1
29	E/C	AT24	**2E-05**	<1	<1
29	E/C	AU22	7E-08	<1	<1
29	E/C	AU23	5E-07	<1	<1
29	E/C	AV22	2E-10	<1	<1
30A	MU	062069	2E-07	<1	<1
30A	MU	064065	1E-07	6E+00	**6E+00**
30A	MU	066068	--	3E+00	**3E+00**

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1.0 for segregated noncancer hazards.

<1 Less than 1
-- Not applicable
bgs Below ground surface
E/C Educational/cultural (industrial exposure scenario)
HI Hazard index
IND Industrial (industrial exposure scenario)
MI Maritime industrial (industrial exposure scenario)
MU Mixed use (residential exposure scenario)
RME Reasonable maximum exposure

TABLE 3-10: INCREMENTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
DMI-1	MI	AX20	5E-10	<1	<1
DMI-1	MI	BA19	4E-10	<1	<1
DMI-1	MI	BA20	--	<1	<1
DMI-1	MI	BA21	7E-08	<1	<1
DMI-1	MI	BA22	1E-06	<1	<1
DMI-1	MI	BA26	**5E-06**	2E+00	<1
DMI-1	MI	BB20	3E-10	<1	<1
DMI-1	MI	BB21	6E-08	<1	<1
DMI-1	MI	BB22	2E-09	<1	<1
DMI-1	MI	BB23	1E-07	<1	<1
DMI-1	MI	BB25	**6E-06**	2E+00	<1
DMI-1	MI	BB26	2E-08	<1	<1
DMI-1	MI	BB29	3E-08	<1	<1
DMI-1	MI	BC21	5E-09	<1	<1
DMI-1	MI	BC22	--	<1	<1
DMI-1	MI	BC24	--	<1	<1
DMI-1	MI	BC26	**6E-06**	<1	<1
DMI-1	MI	BC27	--	<1	<1
DMI-1	MI	BD25	2E-11	<1	<1
DMI-1	MI	BD26	--	<1	<1
DMI-1	MI	BD27	6E-08	<1	<1
DMI-1	MI	BD29	**1E-05**	<1	<1
DMI-1	MI	BE25	6E-08	<1	<1
DMI-1	MI	BE26	**5E-06**	2E+00	<1
DMI-1	MI	BE27	--	<1	<1
DMI-1	MI	BE29	3E-09	<1	<1
DMI-1	MI	BF20	6E-08	<1	<1
DMI-1	MI	BF23	4E-09	<1	<1
DMI-1	MI	BG24	--	<1	<1
DMI-1	MI	BG29	7E-09	<1	<1
DMI-1	MI	BG30	**3E-06**	<1	<1
DMI-1	MI	BG31	**3E-06**	<1	<1
DMI-1	MI	BH23	3E-07	<1	<1
DMI-1	MI	BH24	--	<1	<1
DMI-1	MI	BH30	**3E-06**	<1	<1
DMI-1	MI	BH31	4E-10	<1	<1
DMI-1	MI	BI29	--	<1	<1
DMI-1	MI	BI30	3E-11	<1	<1
DMI-1	MI	BI31	3E-08	<1	<1
DMI-1	MI	BJ30	3E-07	<1	<1
DMI-1	MI	BJ31	**4E-06**	<1	<1
DMI-1	MI	BJ32	4E-08	<1	<1
DMI-1	MI	BK31	3E-07	<1	<1
DMI-1	MI	BK32	4E-08	<1	<1
DMI-1	MI	BL24	**4E-06**	<1	<1
30B	IND	AR24	2E-08	<1	<1
30B	IND	AR25	2E-09	<1	<1
30B	IND	AS24	--	<1	<1
30B	IND	AS25	--	<1	<1
30B	IND	AT25	2E-09	<1	<1
37	IND	AT26	--	<1	<1

TABLE 3-10: INCREMENTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
37	IND	AT27	7E-11	<1	<1
37	IND	AU26	--	<1	<1
37	IND	AV26	--	<1	<1
37	IND	AV28	2E-09	<1	<1
38	IND	AU24	4E-09	<1	<1
38	IND	AV25	**5E-06**	<1	<1
38	IND	AW23	1E-08	<1	<1
38	IND	AW24	3E-09	<1	<1
38	IND	AW25	1E-07	<1	<1
38	IND	AW26	1E-11	<1	<1
38	IND	AX24	2E-10	<1	<1
38	IND	AX25	--	<1	<1
38	IND	AX27	--	<1	<1
38	IND	AY26	**7E-06**	<1	<1
38	IND	AY27	--	<1	<1
38	IND	AZ26	1E-07	<1	<1
42	IND	AY28	--	<1	<1
42	IND	AZ27	6E-09	<1	<1
42	IND	AZ28	7E-12	<1	<1
42	IND	BA28	1E-07	<1	<1
42	IND	BA29	4E-08	<1	<1
42	IND	BB28	5E-08	<1	<1
29	E/C	AS20	**5E-06**	<1	<1
29	E/C	AS22	2E-09	<1	<1
29	E/C	AS23	**3E-06**	<1	<1
29	E/C	AT21	2E-08	<1	<1
29	E/C	AT22	6E-09	<1	<1
29	E/C	AT23	4E-09	<1	<1
29	E/C	AT24	**5E-06**	<1	<1
29	E/C	AU22	6E-09	<1	<1
29	E/C	AU23	5E-08	<1	<1
DOS-1	OS	AT19	2E-08	<1	<1
DOS-1	OS	AT20	3E-07	<1	<1
DOS-1	OS	AU19	4E-08	<1	<1
DOS-1	OS	AU20	**3E-06**	2E+00	<1
DOS-1	OS	AU21	--	<1	<1
DOS-1	OS	AV19	7E-11	<1	<1
DOS-1	OS	AV20	4E-07	<1	<1
DOS-1	OS	AV21	5E-11	<1	<1
DOS-1	OS	AV22	7E-12	<1	<1
DOS-1	OS	AW20	3E-07	<1	<1
DOS-1	OS	AW21	5E-10	<1	<1
39	OS	AW22	--	<1	<1
39	OS	AX21	2E-09	<1	<1
39	OS	AX22	1E-10	<1	<1
39	OS	AX23	--	<1	<1
39	OS	AY23	**3E-06**	<1	<1
39	OS	AY24	2E-09	<1	<1
39	OS	AZ22	1E-10	<1	<1
39	OS	AZ24	5E-09	<1	<1
39	OS	AZ25	3E-08	<1	<1

TABLE 3-10: INCREMENTAL RISK - SUMMARY OF CANCER RISKS AND HAZARD INDICES BY PLANNED REUSE, SURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO (CONTINUED)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI
39	OS	BA23	6E-10	<1	<1
39	OS	BA24	2E-09	<1	<1
39	OS	BA25	6E-09	<1	<1
30A	MU	AQ23	2E-09	<1	<1
30A	MU	AQ24	4E-09	<1	<1

Notes: Values shown in boldface exceed the threshold level of 1E-06 for cancer risks and 1.0 for segregated noncancer hazards.

<1 Less than 1
-- Not applicable
bgs Below ground surface
E/C Educational/cultural (industrial exposure scenario)
HI Hazard index
IND Industrial (industrial exposure scenario)
MI Maritime industrial (industrial exposure scenario)
MU Mixed use (residential exposure scenario)
RME Reasonable maximum exposure

TABLE 3-11: INCREMENTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SURFACE SOIL (0 TO 2 FEET BGS) BY PLANNED REUSE

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

													Percent Contribution by Exposure Pathway to Total RME Cancer Risk					Percent Contribution by Exposure Pathway to Total RME HI			
Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Conern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-specific HI	Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion
DMI-1	MI	BA22	8.80E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.057 - 1	1.00E+00	3/5	5.70E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
							Benzo(b)fluoranthene	C	0.094 - 2.2	2.20E+00	3/5	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BA26	3.13E-05	<1	<1	Metal	Arsenic	C	4.9 - 13.1	1.31E+01	3/3	3.02E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BB25	2.87E-05	<1	<1	Metal	Arsenic	C	7.9 - 12.4	1.24E+01	2/2	2.86E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BE26	3.80E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.47 - 0.47	4.70E-01	1/3	2.68E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BG31	5.26E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.88 - 0.88	8.80E-01	1/11	5.01E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BH30	3.32E-05	<1	<1	Metal	Arsenic	C	4 - 13.9	1.39E+01	4/4	3.21E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BJ30	3.01E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.011 - 0.51	2.82E-01	8/14	1.60E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BJ31	3.17E-05	<1	<1	Metal	Arsenic	C	4.3 - 17	1.25E+01	8/8	2.88E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
							Benzo(a)pyrene	C	0.017 - 0.35	3.50E-01	3/8	1.99E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BL24	2.54E-05	<1	<1	Metal	Arsenic	C	1.9 - 13.6	1.02E+01	9/9	2.35E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
							Benzo(a)pyrene	C	0.22 - 0.22	2.20E-01	1/7	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
29	E/C	AS20	2.47E-05	<1	<1	Metal	Arsenic	C	5.2 - 12.5	1.06E+01	5/6	2.44E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
29	E/C	AS23	3.17E-05	<1	<1	Metal	Arsenic	C	0.4 - 15	1.34E+01	13/15	3.08E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
29	E/C	AT22	7.19E-02	<1	<1	Metal	Lead	NC	7.7 - 920	9.20E+02	3/3	--	--	--	--		--	--	--	--	
29	E/C	AT24	3.14E-05	<1	<1	Metal	Arsenic	C	1.9 - 14.2	1.28E+01	4/4	2.96E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.3 - 0.3	3.00E-01	1/5	1.71E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DOS-1	OS	AT20	3.14E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.021 - 0.24	2.40E-01	3/15	1.84E-06	28 %	71.9 %	0.0 %		--	--	--	--	
DOS-1	OS	AV20	4.21E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.49 - 0.49	4.90E-01	1/1	3.75E-06	28 %	71.9 %	0.0 %		--	--	--	--	
DOS-1	OS	AW20	3.75E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.27 - 0.27	2.70E-01	1/3	2.07E-06	28 %	71.9 %	0.0 %		--	--	--	--	
39	OS	AY23	1.27E-04	<1	<1	Metal	Arsenic	C	0.45 - 47.2	4.72E+01	3/5	1.27E-04	62.8 %	37.2 %	0.0 %		<1	--	--	--	
30A	MU	066068	--	2.67E+00	2.67E+00	Metal	Manganese	NC	1,520 - 2,020	2.02E+03	2/2	--	--	--	--	--	2.40E+00	44.9 %	0.0 %	2.9 %	52.2 %

Notes: All concentrations shown in mg/kg.

<1 Less than 1

-- Not applicable or chemical is not a chemical of concern for this endpoint

[shaded] Not evaluated because exposure pathway is incomplete

bgs Below ground surface

C Cancer effect

E/C Educational/cultural (industrial exposure scenario)

EPC Exposure point concentration

HI Hazard index

HPAL Hunters Point ambient level

MI Maritime industrial (industrial exposure scenario)

MU Mixed use (residential exposure scenario)

OS Open space (recreational exposure scenario)

RME Reasonable maximum exposure

TABLE 3-12: INCREMENTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SUBSURFACE SOIL (0 TO 10 FEET BGS) BY PLANNED REUSE
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Percent Contribution by Exposure Pathway to Total RME Cancer Risk: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion	Chemical-specific HI	Percent Contribution by Exposure Pathway to Total RME HI: Incidental Ingestion	Dermal Contact	Inhalation (Releases to Ambient Air)	Home-grown Produce Ingestion
DMI-1	MI	BA22	8.82E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.057 - 1	1.00E+00	3/12	5.70E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
							Benzo(b)fluoranthene	C	0.094 - 2.2	2.20E+00	3/12	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BA26	2.43E-05	<1	<1	Metal	Arsenic	C	2.5 - 13.1	1.01E+01	4/5	2.33E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BB25	2.87E-05	<1	<1	Metal	Arsenic	C	7.2 - 12.4	1.24E+01	3/3	2.86E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BC26	3.27E-05	<1	<1	Metal	Arsenic	C	1.6 - 25.3	1.36E+01	16/19	3.13E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BD29	5.67E-05	<1	<1	Metal	Arsenic	C	8.4 - 22.3	2.23E+01	2/2	5.14E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.57 - 0.57	5.70E-01	1/1	3.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BE26	2.45E-05	<1	<1	Metal	Arsenic	C	2.6 - 24.8	8.93E+00	13/13	2.06E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.47 - 0.47	4.70E-01	1/6	2.68E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BG30	1.36E-05	<1	<1	Metal	Arsenic	C	2.6 - 16.6	5.66E+00	38/39	1.31E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BG31	1.89E-05	<1	<1	Metal	Arsenic	C	1.6 - 12	6.82E+00	29/29	1.57E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.017 - 0.88	4.33E-01	7/31	2.46E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BH23	2.45E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.32 - 0.32	3.20E-01	1/3	1.82E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BH30	1.71E-05	<1	<1	Metal	Arsenic	C	3.1 - 13.9	6.94E+00	18/19	1.60E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
DMI-1	MI	BJ30	2.51E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.011 - 0.51	2.65E-01	8/25	1.51E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BJ31	2.33E-05	<1	<1	Metal	Arsenic	C	2.1 - 17	8.87E+00	19/19	2.05E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.017 - 0.35	3.50E-01	3/28	1.99E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BK31	2.39E-06	<1	<1	PAH	Benzo(a)pyrene	C	0.015 - 0.28	2.80E-01	3/12	1.59E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
DMI-1	MI	BL24	2.10E-05	<1	<1	Metal	Arsenic	C	0.39 - 13.6	8.33E+00	19/30	1.92E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.22 - 0.22	2.20E-01	1/27	1.25E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
38	IND	AV25	2.40E-05	<1	<1	Metal	Arsenic	C	2.5 - 11.3	9.41E+00	7/8	2.17E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.13 - 0.19	1.90E-01	2/7	1.08E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
38	IND	AY26	3.51E-05	<1	<1	Metal	Arsenic	C	2 - 15.2	1.52E+01	4/4	3.50E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
29	E/C	AS20	2.46E-05	<1	<1	Metal	Arsenic	C	5.2 - 12.5	1.06E+01	6/7	2.44E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
29	E/C	AS23	1.36E-05	<1	<1	Metal	Arsenic	C	0.3025 - 15	5.42E+00	34/41	1.25E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
29	E/C	AT22	5.19E-02	<1	<1	Metal	Lead	NC	2.1 - 920	9.20E+02	8/9	--	--	--	--		--	--	--	--	
29	E/C	AT24	2.37E-05	<1	<1	Metal	Arsenic	C	0.47 - 14.2	9.47E+00	12/14	2.18E-05	71.6 %	28.4 %	0.0 %		<1	--	--	--	
						PAH	Benzo(a)pyrene	C	0.3 - 0.3	3.00E-01	1/15	1.71E-06	36.8 %	63.2 %	0.0 %		--	--	--	--	
30A	MU	064065	1.28E-07	6.07E+00	5.88E+00	Metal	Manganese	NC	4,830 - 4,830	4.83E+03	1/1	--	--	--	--	--	5.73E+00	44.9 %	0.0 %	2.9 %	52.2 %
30A	MU	066068	--	2.67E+00	2.67E+00	Metal	Manganese	NC	1,520 - 2,020	2.02E+03	2/2	--	--	--	--	--	2.40E+00	44.9 %	0.0 %	2.9 %	52.2 %

Notes: All concentrations shown in mg/kg.

<1	Less than 1
--	Not applicable or chemical is not a chemical of concern for this endpoint
*	Not available; comparison to ambient levels based on regression analysis
(shaded)	Not evaluated because exposure pathway is incomplete
bgs	Below ground surface
C	Cancer effect
E/C	Educational/cultural (industrial exposure scenario)
EPC	Exposure point concentration
HI	Hazard index
HPAL	Hunters Point ambient level
IND	Industrial (industrial exposure scenario)
mg/kg	Milligrams per kilogram
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
NC	Noncancer effect
PAH	Polynuclear aromatic hydrocarbon
PRG	Preliminary remediation goal
OS	Open space (recreational exposure scenario)
RME	Reasonable maximum exposure

TABLE 3-13: INCREMENTAL RISK - RISK CHARACTERIZATION ANALYSIS FOR SUBSURFACE SOIL (0 TO 10 FEET BGS), CONSTRUCTION WORKER SCENARIO

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Chemicals of Concern		Basis for Chemical of Concern	Range of Detected Concentrations	RME EPC	Detection Frequency	Chemical-Specific Cancer Risk	Chemical-Specific HI	Metals	
														HPAL	Maximum Concentration Exceeds HPAL?
DMI-1	MI	BA22	2.39E-06	1.09E+00	<1	PAH	Benzo(a)pyrene	C	0.057 - 1	1.00E+00	3/12	1.55E-06	--	--	--
DMI-1	MI	BA26	6.51E-06	1.67E+00	<1	Metal	Arsenic	C	2.5 - 13.1	1.01E+01	4/5	6.23E-06	<1	11.1	Yes
DMI-1	MI	BB25	7.66E-06	1.75E+00	<1	Metal	Arsenic	C	7.2 - 12.4	1.24E+01	3/3	7.65E-06	<1	11.1	Yes
DMI-1	MI	BC26	8.69E-06	1.48E+00	<1	Metal	Arsenic	C	1.6 - 25.3	1.36E+01	16/19	8.37E-06	<1	11.1	Yes
DMI-1	MI	BD29	1.51E-05	<1	<1	Metal	Arsenic	C	8.4 - 22.3	2.23E+01	2/2	1.38E-05	<1	11.1	Yes
DMI-1	MI	BE26	6.58E-06	2.47E+00	1.41E+00	Metal	Arsenic	C	2.6 - 24.8	8.93E+00	13/13	5.50E-06	<1	11.1	Yes
							Manganese	NC	99.4 - 9,270	9.27E+03	9/9	--	1.35E+00	1431.18	Yes
DMI-1	MI	BG30	3.59E-06	<1	<1	Metal	Arsenic	C	2.6 - 16.6	5.66E+00	38/39	3.49E-06	<1	11.1	Yes
DMI-1	MI	BG31	5.06E-06	1.38E+00	<1	Metal	Arsenic	C	1.6 - 12	6.82E+00	29/29	4.21E-06	<1	11.1	Yes
DMI-1	MI	BH30	4.59E-06	1.24E+00	<1	Metal	Arsenic	C	3.1 - 13.9	6.94E+00	18/19	4.28E-06	<1	11.1	Yes
DMI-1	MI	BJ31	6.24E-06	<1	<1	Metal	Arsenic	C	2.1 - 17	8.87E+00	19/19	5.47E-06	<1	11.1	Yes
DMI-1	MI	BL24	5.61E-06	<1	<1	Metal	Arsenic	C	0.39 - 13.6	8.33E+00	19/30	5.13E-06	<1	11.1	Yes
38	IND	AV25	6.42E-06	1.18E+00	<1	Metal	Arsenic	C	2.5 - 11.3	9.41E+00	7/8	5.80E-06	<1	11.1	Yes
38	IND	AY26	9.38E-06	<1	<1	Metal	Arsenic	C	2 - 15.2	1.52E+01	4/4	9.37E-06	<1	11.1	Yes
29	E/C	AS20	6.59E-06	<1	<1	Metal	Arsenic	C	5.2 - 12.5	1.06E+01	6/7	6.53E-06	<1	11.1	Yes
29	E/C	AS23	3.58E-06	1.53E+00	<1	Metal	Arsenic	C	0.3025 - 15	5.42E+00	34/41	3.34E-06	<1	11.1	Yes
29	E/C	AT22	5.19E-02	<1	<1	Metal	Lead	NC	2.1 - 920	9.20E+02	8/9	--	--	8.99	Yes
29	E/C	AT24	6.33E-06	<1	<1	Metal	Arsenic	C	0.47 - 14.2	9.47E+00	12/14	5.84E-06	<1	11.1	Yes
DOS-1	OS	AU20	4.58E-06	1.64E+00	<1	Metal	Arsenic	C	0.55 - 24	7.32E+00	20/24	4.51E-06	<1	11.1	Yes
39	OS	AY23	4.59E-06	<1	<1	Metal	Arsenic	C	0.45 - 47.2	7.32E+00	13/20	4.51E-06	<1	11.1	Yes

Notes: All concentrations shown in mg/kg.

<1	Less than 1
--	Not applicable or chemical is not a chemical of concern for this endpoint
bgs	Below ground surface
C	Cancer effect
E/C	Educational/cultural (industrial exposure scenario)
EPC	Exposure point concentration
HI	Hazard index
HPAL	Hunters Point ambient level
IND	Industrial (industrial exposure scenario)
mg/kg	Milligrams per kilogram
MI	Maritime industrial (industrial exposure scenario)
NC	Noncancer effect
PAH	Polynuclear aromatic hydrocarbon
OS	Open space (recreational exposure scenario)
RME	Reasonable maximum exposure

TABLE 3-14: RISK CHARACTERIZATION ANALYSIS FOR A-AQUIFER GROUNDWATER BASED ON PLANNED REUSE
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Exposure Area	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Exposure Pathway	Source Aquifer for Exposure Pathway	Total RME Cancer Risk for Exposure Pathway	Total RME HI for Exposure Pathway	Chemicals of Concern		Basis for Chemical of Concern	Detection Frequency	RME Concentration	Chemical-Specific Cancer Risk	Percent Contribution to Total RME Cancer Risk for Exposure Pathway	Chemical-Specific HI	Percent Contribution to Total RME HI for Exposure Pathway
30A	MU	IR-09 Plume	2.20E-05	6.49E-01	6.42E-01	Vapor Intrusion	A	2.20E-05	6.49E-01	VOC	Chloroform	C	7 / 34	1.3E+00	1.8E-06	8.4	--	--
											Methylene Chloride	C	1 / 34	4.5E+01	1.7E-06	7.6	--	--
											Trichloroethene	C	6 / 34	5.3E+01	1.8E-05	84.1	--	--
30B, 29, 37, 38	IND and E/C	IR-09 Plume	1.31E-05	6.49E-01	6.42E-01	Vapor Intrusion	A	1.31E-05	6.49E-01	VOC	Chloroform	C	7 / 34	1.3E+00	1.1E-06	8.4	--	--
											Trichloroethene	C	6 / 34	5.3E+01	1.1E-05	84.1	--	--
29, 38, DMI-1	IND, E/C and MI	IR-33 Plume	9.81E-04	8.59E+00	4.58E+00	Vapor Intrusion	A	9.81E-04	8.59E+00	VOC	Benzene	C, NC	6 / 37	6.1E+02	9.6E-04	98.1	4.6E+00	53.3
											Carbon Tetrachloride	C	2 / 37	3.0E-01	3.9E-06	0.4	--	--
											Chloroform	C	16 / 37	4.7E+00	4.0E-06	0.4	--	--
											Naphthalene	C	2 / 24	5.6E+01	9.3E-06	0.9	--	--
											Xylene (Total)	NC	7 / 37	1.1E+03	--	--	3.3E+00	38
38, 42, DMI-1	IND and MI	IR-71 Plume	3.81E-05	1.09E+00	4.58E-01	Vapor Intrusion	A	3.81E-05	1.09E+00	VOC	Carbon Tetrachloride	C	2 / 13	9.00E-01	1.18E-05	30.9	--	--
											Chloroform	C	10 / 13	1.96E+00	1.67E-06	4.4	--	--
											Tetrachloroethene	C	6 / 13	1.97E+01	2.18E-05	57.2	--	--
											Trichloroethene	C	7 / 13	1.39E+01	2.88E-06	7.5	--	--
DMI-1	IND	BH24	8.09E-06	2.92E-02	2.92E-02	Vapor Intrusion	A	8.09E-06	2.92E-02	VOC	Chloroform	C	1 / 3	9.50E+00	8.09E-06	100	2.92E-02	100
38	IND	AU25	5.96E-06	2.15E-02	2.15E-02	Vapor Intrusion	A	5.96E-06	2.15E-02	VOC	Chloroform	C	2 / 6	7.00E+00	5.96E-06	100	2.15E-02	100
38	IND	AX27	1.76E-05	7.02E-02	7.02E-02	Vapor Intrusion	A	1.76E-05	7.02E-02	VOC	Chloroform	C	1 / 4	2.05E+01	1.75E-05	99.3	6.30E-02	89.7

Notes: All concentrations shown in micrograms per liter.

--	Not applicable or chemical is not a chemical of concern for this endpoint
C	Cancer effect
E/C	Educational/cultural (industrial exposure scenario)
HI	Hazard index
IND	Industrial (industrial exposure scenario)
IR	Installation Restoration
MI	Maritime industrial (industrial exposure scenario)
MU	Mixed use (residential exposure scenario)
NC	Noncancer effect
RME	Reasonable maximum exposure
VOC	Volatile organic compound

TABLE 3-15: RISK CHARACTERIZATION SUMMARY FOR A-AQUIFER GROUNDWATER, CONSTRUCTION WORKER SCENARIO
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Exposure Area	Total RME Cancer Risk	Total RME HI	RME Segregated HI	Exposure Pathway	Source Aquifer for Exposure Pathway	Total RME Cancer Risk for Exposure Pathway	Total RME HI for Exposure Pathway	Chemicals of Concern		Basis for Chemical of Concern	Detection Frequency	RME Concentration	Chemical-Specific Cancer Risk	Percent Contribution to Total RME Cancer Risk for Exposure Pathway	Chemical-Specific HI	Percent Contribution to Total RME HI for Exposure Pathway
29, 38, DMI-1	IND, E/C, and MI	IR-33 Plume	3.92E-05	6.91E+00	3.06E+00	Trench Vapor Inhalation	A	3.52E-05	5.83E+00	VOC	Benzene	C, NC	6 / 37	6.1E+02	3.2E-05	92.1	2.6E+00	45.3
											Naphthalene	C, NC	2 / 24	5.6E+01	2.5E-06	7.2	1.7E+00	29.7
											Xylene (Total)	NC	7 / 37	1.1E+03	--	--	1.2E+00	20.9
						Trench Dermal Contact	A	4.08E-06	1.08E+00	VOC	Benzene	C, NC	6 / 37	6.1E+02	2.4E-06	57.9	--	--
42, 38, DMI-1	IND and MI	IR-71 Plume	1.67E-06	9.76E-01	6.68E-01	Trench Vapor Inhalation	A	3.15E-07	1.57E-01	VOC	Tetrachloroethene	C	6 / 13	1.97E+01	1.5E-07	48.6	--	--
						Trench Dermal Contact	A	1.35E-06	8.19E-01	VOC	Tetrachloroethene	C	6 / 13	1.97E+01	9.3E-07	68.8	--	--
DMI-1	MI	BB20	1.57E-06	3.92E-02	3.86E-02	Trench Dermal Contact	A	1.6E-06	3.9E-02	Metal	Arsenic	C	1 / 5	6.3E+01 J	1.6E-06	100	3.9E-02	100

Notes: All concentrations shown in micrograms per liter.

--	Not applicable or chemical is not a chemical of concern for this endpoint
C	Cancer effect
E/C	Educational/cultural
HI	Hazard index
IND	Industrial
IR	Installation Restoration
MI	Maritime industrial
NC	Noncancer effect
RME	Reasonable maximum exposure
VOC	Volatile organic compound

TABLE 3-16: REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Exposure Scenario	Chemical of Concern[a]	Redevelopment Block	RBC	HPAL	Laboratory Practical Quantitation Limit	Remediation Goal
Residential	Manganese	30A	843	1,431	0.05	1,431
Recreational	Arsenic	39	0.37	11.1	0.2	11.1
	Benzo(a)pyrene	DOS-1	0.13	--	0.33	0.33
Industrial	Arsenic	DMI-1, 29, and 38	0.43	11.1	0.2	11.1
	Benzo(a)pyrene	DMI-1, 29, and 38	0.18	--	0.33	0.33
	Benzo(b)fluoranthene	DMI-1	1.76	--	0.33	1.76
	Lead	29	800	8.99	0.6	800
Construction Worker	Arsenic	DMI-1, DOS-1, 29, 38, and 39	1.62	11.1	0.2	11.1
	Benzo(a)pyrene	DMI-1	0.65	--	0.33	0.65
	Lead	29	800	8.99	0.6	800
	Manganese	DMI-1	6,889	1,431	0.05	6,889

Notes: All concentrations shown in milligrams per kilogram.

a Chemicals of concern shown are based on the results of the incremental risk evaluation for soil.

-- Not applicable
HPAL Hunters Point ambient level
RBC Exposure scenario-specific risk-based concentration

TABLE 3-17: REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN A-AQUIFER GROUNDWATER

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Exposure Scenario	Chemical of Concern	Associated Plume[a] or Grid Number	RBC	HGAL	Laboratory Practical Quantitation Limit	Remediation Goal
Residential - Vapor Intrusion	Chloroform	IR-09	0.7	--	1	1.0
	Methylene Chloride	IR-09	27	--	1	27
	Trichloroethene	IR-09	2.9	--	1	2.9
Industrial - Vapor Intrusion	Benzene	IR-33	0.63	--	0.5	0.63
	Carbon Tetrachloride	IR-33 and IR-71	0.08	--	0.5	0.5
	Chloroform	IR-09, IR-33, IR-71, AU25, AX27, and BH24	1.2	--	1	1.2
	Naphthalene	IR-33	6.0	--	1	6.0
	Tetrachloroethene	IR-71	0.9	--	1	1.0
	Trichloroethene	IR-09, IR-71	4.8	--	1	4.8
	Xylene (total)	IR-33	337	--	0.5	337
Construction Worker - Trench Exposure	Arsenic	BB20	40	27.34	1	40
	Benzene	IR-33	17	--	0.5	17
	Naphthalene	IR-33	17	--	1	17
	Tetrachloroethene	IR-71	18	--	1	18
	Xylene (total)	IR-33	861	--	0.5	861

Notes: All concentrations shown in micrograms per liter.

a The plumes listed (IR-09, IR-33, IR-71) are those defined for the risk assessment (see Attachment B4 of Appendix B)

-- Not applicable

HGAL Hunters Point groundwater ambient level

IR Installation Restoration

RBC Exposure scenario-specific risk-based concentration

TABLE 3-18: RISK AND HAZARD DRIVERS AND ASSOCIATED SAMPLING LOCATIONS EXCEEDING REMEDIATION GOALS BY PLANNED REUSE, SURFACE SOIL (0 TO 2 FEET BGS)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

													Significant Sampling Information			
Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI	Chemicals of Concern		Chemical-Specific Cancer Risk	Chemical-Specific HI	Detection Frequency	RME EPC (mg/kg)	Remediation Goal	Sampling Location	Sampling Top Depth (feet bgs)	Sampling Bottom Depth (feet bgs)	Detected Concentration (mg/kg)
DMI-1	MI	BA22	8.80E-06	<1	<1	PAH	Benzo(a)pyrene	5.70E-06	--	3/5	1.00E+00	3.30E-01	IR35SS14	0.25	0.25	1
													IR35SS15	0.25	0.25	0.49
							Benzo(b)fluoranthene	1.25E-06	--	3/5	2.20E+00	1.76E+00	IR35SS14	0.25	0.25	2.2
DMI-1	MI	BA26	3.13E-05	<1	<1	Metal	Arsenic	3.02E-05	3.00E-02	3/3	1.31E+01	1.11E+01	IR70SS01	0	0	13.1
DMI-1	MI	BB25	2.87E-05	<1	<1	Metal	Arsenic	2.86E-05	2.84E-02	2/2	1.24E+01	1.11E+01	PA55SS15	0.75	0.75	12.4
DMI-1	MI	BE26	3.80E-06	<1	<1	PAH	Benzo(a)pyrene	2.68E-06	--	1/3	4.70E-01	3.30E-01	PA55TA04	1.25	1.25	0.47
DMI-1	MI	BG31	2.07E-05	<1	<1	Metal	Arsenic	1.54E-05	1.53E-02	15/15	6.68E+00	1.11E+01	No samples exceed remediation goals			
						PAH	Benzo(a)pyrene	5.01E-06	--	1/11	8.80E-01	3.30E-01	PA53SS03	0	0	0.88
DMI-1	MI	BH30	3.32E-05	<1	<1	Metal	Arsenic	3.21E-05	3.19E-02	4/4	1.39E+01	1.11E+01	IR69B003	0	0.5	13.9
													IR69B004	0.5	1.5	11.7
DMI-1	MI	BJ30	3.01E-06	<1	<1	PAH	Benzo(a)pyrene	1.60E-06	--	8/14	2.82E-01	3.30E-01	SPD31	0	0.5	0.34
													SPD31	0	0.5	0.51
DMI-1	MI	BJ31	3.17E-05	<1	<1	Metal	Arsenic	2.88E-05	2.87E-02	8/8	1.25E+01	1.11E+01	SPD24	0	0.5	13
													SPD23	0	0.5	17
						PAH	Benzo(a)pyrene	1.99E-06	--	3/8	3.50E-01	3.30E-01	SPD23	0	0.5	0.35
DMI-1	MI	BL24	2.54E-05	<1	<1	Metal	Arsenic	2.35E-05	2.34E-02	9/9	1.02E+01	1.11E+01	IR68B007	0	1	13.6
						PAH	Benzo(a)pyrene	1.25E-06	--	1/7	2.20E-01	3.30E-01	No samples exceed remediation goals			
29	E/C	AS20	2.47E-05	<1	<1	Metal	Arsenic	2.44E-05	2.43E-02	5/6	1.06E+01	1.11E+01	IR33B078	1.75	1.75	12.5
29	E/C	AS23	3.17E-05	<1	<1	Metal	Arsenic	3.08E-05	3.07E-02	13/15	1.34E+01	1.11E+01	IR09B007	1.25	1.25	12.7
													6967E1B	1.5	2	15
29	E/C	AT22	7.19E-02	<1	<1	Metal	Lead	--	--	3/3	9.20E+02	8.00E+02	IR09B030	1.25	1.25	920
29	E/C	AT24	3.14E-05	<1	<1	Metal	Arsenic	2.96E-05	2.94E-02	4/4	1.28E+01	1.11E+01	IR09B017	1.25	1.25	14.2
						PAH	Benzo(a)pyrene	1.71E-06	--	1/5	3.00E-01	3.30E-01	No samples exceed remediation goals			
DOS-1	OS	AT20	3.14E-06	<1	<1	PAH	Benzo(a)pyrene	1.84E-06	--	3/15	2.40E-01	3.30E-01	No samples exceed remediation goals			
DOS-1	OS	AV20	4.21E-06	<1	<1	PAH	Benzo(a)pyrene	3.75E-06	--	1/1	4.90E-01	3.30E-01	IR33B091	1.25	1.25	0.49
DOS-1	OS	AW20	3.75E-06	<1	<1	PAH	Benzo(a)pyrene	2.07E-06	--	1/3	2.70E-01	3.30E-01	No samples exceed remediation goals			
39	OS	AY23	1.27E-04	<1	<1	Metal	Arsenic	1.27E-04	3.51E-01	3/5	4.72E+01	1.11E+01	IR65B004	0.5	1.5	47.2
30A	MU	066068	--	2.67E+00	2.67E+00	Metal	Manganese	--	2.40E+00	2/2	2.02E+03	1.43E+03	PA37SS04	1	1.5	2,020
													PA37SS04	1.25	1.25	1,520

Notes:

<1	Less than 1	mg/kg	Milligrams per kilogram
--	Not applicable	MI	Maritime industrial (industrial exposure scenario)
bgs	Below ground surface	MU	Mixed use (residential exposure scenario)
E/C	Educational/cultural (industrial exposure scenario)	OS	Open space (recreational exposure scenario)
EPC	Exposure point concentration	PAH	Polynuclear aromatic hydrocarbon
HI	Hazard index	RME	Reasonable maximum exposure
IND	Industrial (industrial exposure scenario)		

TABLE 3-19: RISK AND HAZARD DRIVERS AND ASSOCIATED SAMPLING LOCATIONS EXCEEDING REMEDIATION GOALS BY PLANNED REUSE, SUBSURFACE SOIL (0 TO 10 FEET BGS)

Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

Redevelopment Block	Planned Reuse	Grid Number	RME Cancer Risk	RME HI	RME Segregated HI	Chemicals of Concern		Chemical-Specific Cancer Risk	Chemical-Specific HI	Detection Frequency	RME EPC (mg/kg)	Remediation Goal	Significant Sampling Information: Sampling Location	Sampling Top Depth (feet bgs)	Sampling Bottom Depth (feet bgs)	Detected Concentration (mg/kg)
DMI-1	MI	BA22	9E-06	<1	<1	PAH	Benzo(a)pyrene	5.70E-06	–	3/12	1.00E+00	3.30E-01	IR35SS15	0.25	0.25	0.49
													IR35SS14	0.25	0.25	1
							Benzo(b)fluoranthene	1.25E-06	–	3/12	2.20E+00	1.76E+00	IR35SS14	0.25	0.25	2.2
DMI-1	MI	BA26	2E-05	<1	<1	Metal	Arsenic	2.33E-05	2.32E-02	4/5	1.01E+01	1.11E+01	IR70SS01	0	0	13.1
DMI-1	MI	BB25	3E-05	<1	<1	Metal	Arsenic	2.86E-05	2.84E-02	3/3	1.24E+01	1.11E+01	PA55SS15	0.75	0.75	12.4
DMI-1	MI	BC26	3E-05	<1	<1	Metal	Arsenic	3.13E-05	3.11E-02	16/19	1.36E+01	1.11E+01	IR55B025	3.75	3.75	18.3
													PA55B013	5.25	5.25	14.2
													IR55B025	5.75	5.75	25.3
DMI-1	MI	BD29	6E-05	<1	<1	Metal	Arsenic	5.14E-05	5.12E-02	2/2	2.23E+01	1.11E+01	PA55TA10	3.5	3.5	22.3
						PAH	Benzo(a)pyrene	3.25E-06	–	1/1	5.70E-01	3.30E-01	PA55TA10	3.5	3.5	0.57
DMI-1	MI	BE26	2E-05	<1	<1	Metal	Arsenic	2.06E-05	2.05E-02	13/13	8.93E+00	1.11E+01	IR55B019	5.75	5.75	24.8
						PAH	Benzo(a)pyrene	2.68E-06	–	1/6	4.70E-01	3.30E-01	PA55TA04	1.25	1.25	0.47
DMI-1	MI	BG30	1E-05	<1	<1	Metal	Arsenic	1.31E-05	1.30E-02	38/39	5.66E+00	1.11E+01	IR53B029	6	7	16.6
DMI-1	MI	BG31	2E-05	<1	<1	Metal	Arsenic	1.57E-05	1.57E-02	29/29	6.82E+00	1.11E+01	IR16B012	6.25	6.25	12
						PAH	Benzo(a)pyrene	2.46E-06	–	7/31	4.33E-01	3.30E-01	PA53SS03	0	0	0.88
DMI-1	MI	BH23	2E-06	<1	<1	PAH	Benzo(a)pyrene	1.82E-06	–	1/3	3.20E-01	3.30E-01	No samples exceed remediation goals			
DMI-1	MI	BH30	2E-05	<1	<1	Metal	Arsenic	1.60E-05	1.59E-02	18/19	6.94E+00	1.11E+01	IR69B003	0	0.5	13.9
													IR69B004	0.5	1.5	11.7
DMI-1	MI	BJ30	3E-06	<1	<1	PAH	Benzo(a)pyrene	1.51E-06	–	8/25	2.65E-01	3.30E-01	SPD31	0	0.5	0.34
													SPD31	0	0.5	0.51
DMI-1	MI	BJ31	2E-05	<1	<1	Metal	Arsenic	2.05E-05	2.04E-02	19/19	8.87E+00	1.11E+01	SPD24	0	0.5	13
													SPD23	0	0.5	17
						PAH	Benzo(a)pyrene	1.99E-06	–	3/28	3.50E-01	3.30E-01	SPD23	0	0.5	0.35
DMI-1	MI	BK31	2E-06	<1	<1	PAH	Benzo(a)pyrene	1.59E-06	–	3/12	2.80E-01	3.30E-01	No samples exceed remediation goals			
DMI-1	MI	BL24	2E-05	<1	<1	Metal	Arsenic	1.92E-05	1.91E-02	19/30	8.33E+00	1.11E+01	IR68B007	0	1	13.6
						PAH	Benzo(a)pyrene	1.25E-06	–	1/27	2.20E-01	3.30E-01	No samples exceed remediation goals			
38	IND	AV25	2E-05	<1	<1	Metal	Arsenic	2.17E-05	2.16E-02	7/8	9.41E+00	1.11E+01	IR33B094	6.5	7	11.3
						PAH	Benzo(a)pyrene	1.08E-06	–	2/7	1.90E-01	3.30E-01	No samples exceed remediation goals			
38	IND	AY26	4E-05	<1	<1	Metal	Arsenic	3.50E-05	3.49E-02	4/4	1.52E+01	1.11E+01	IR50B020	6.25	6.25	15.2
29	E/C	AS20	2E-05	<1	<1	Metal	Arsenic	2.44E-05	2.43E-02	6/7	1.06E+01	1.11E+01	IR33B078	1.75	1.75	12.5
29	E/C	AS23	1E-05	<1	<1	Metal	Arsenic	1.25E-05	1.24E-02	34/41	5.42E+00	1.11E+01	IR09B007	1.25	1.25	12.7
													6967E1B	1.5	2	15
29	E/C	AT22	5E-02	<1	<1	Metal	Lead	–	–	8/9	9.20E+02	8.00E+02	IR09B030	1.25	1.25	920
29	E/C	AT24	2E-05	<1	<1	Metal	Arsenic	2.18E-05	2.17E-02	12/14	9.47E+00	1.11E+01	IR09B017	1.25	1.25	14.2
						PAH	Benzo(a)pyrene	1.71E-06	–	1/15	3.00E-01	3.30E-01	No samples exceed remediation goals			
30A	MU	064065	1E-07	6.07E+00	5.88E+00	Metal	Manganese	–	5.73E+00	1/1	4.83E+03	1.43E+03	IR09MW63A	4	5	4,830
30A	MU	066068	–	2.67E+00	2.67E+00	Metal	Manganese	–	2.40E+00	2/2	2.02E+03	1.43E+03	PA37SS04	1	1.5	2,020
													PA37SS04	1.25	1.25	1,520

Notes:

<1	Less than 1	mg/kg	Milligrams per kilogram
–	Not applicable	MI	Maritime industrial (industrial exposure scenario)
bgs	Below ground surface	MU	Mixed use (residential exposure scenario)
E/C	Educational/cultural (industrial exposure scenario)	OS	Open space (recreational exposure scenario)
EPC	Exposure point concentration	PAH	Polynuclear aromatic hydrocarbon
HI	Hazard index	RME	Reasonable maximum exposure
IND	Industrial (industrial exposure scenario)		

4.0 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, AND PROCESS OPTIONS

This section presents (1) site-specific RAOs for soil and groundwater at Parcel D based on the COCs and remediation goals derived in Section 3.0 (see Section 4.1), (2) identifies ARARs (see Section 4.2), and (3) presents a range of GRAs and associated process options that will satisfy the RAOs (see Section 4.3). The GRAs and process options retained through the screening process will then be used in later sections as the basis for developing remedial alternatives.

4.1 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific goals for protecting human health and the environment. Each RAO should specify (1) the COC(s), (2) the exposure route and receptor(s), and (3) an acceptable contaminant concentration or range of concentrations for each media of concern (such as soil and groundwater). RAOs include both an exposure pathway and a contaminant concentration in a given media because protectiveness may be achieved in two ways: limiting or eliminating the exposure pathway or reducing contaminant concentrations.

The RAO evaluation for Parcel D is based on information from the RI, subsequent environmental investigations and risk evaluations for human health and the environment. The NCP details the expectations for remedy selection in Title 40 of the *Code of Federal Regulations* (40 CFR) Part 300.430 (a)(1)(iii). These expectations were used to evaluate RAOs for Parcel D. In addition, the U.S. Department of Defense integrates these NCP expectations with BRAC program objectives for expediting transfer of U.S. Department of Defense property for reuse and development.

An important component of developing RAOs is the determination of future land use. According to EPA's land use directive (EPA 1995), RAOs "...should reflect the reasonably anticipated future land use or uses...," thereby allowing for the development of "alternatives that would achieve cleanup levels associated with the reasonably anticipated future land use..." of the site. The EPA land use directive states that "in cases where future land use is relatively certain, the RAOs generally should reflect this land use..." and "...need not include alternative land use scenarios..." (EPA 1995). RAOs developed for Parcel D are based on the City and County of San Francisco's planned reuse for each redevelopment block, which are considered the reasonable anticipated end use of the property as described in the HHRA. In accordance with the EPA land use directive, this FS develops remedial alternatives based on the planned reuse only. RAOs for a stadium reuse would be similar to the soil and groundwater objectives presented in this section. COCs and cleanup goals would likely be based on contamination to 2 feet, consistent with recreational reuse and plans for complete covers across the site. RAOs for groundwater would be based on the recreational scenario across the bulk of the site, minimizing the need for remediation of VOCs in groundwater outside of the stadium footprint. Other reuse scenarios were developed in the HHRA for this revised FS report and are included in Appendix B. These additional reuse scenarios are provided as a basis for implementing the RD if the presently proposed land use changes prior to the final ROD.

4.1.1 Remedial Action Objectives for Soil

Separate RAOs are typically developed for human health receptors and for ecological receptors. For Parcel D, no ecological soil RAOs were developed because most of the land area is paved and the parcel contains no identified terrestrial habitat. There is insufficient unpaved area to develop a terrestrial ecological habitat. The proposed future land use is primarily industrial, with limited areas planned for mixed use and active recreation open space, which would not increase the potential ecological habitat lands (San Francisco Redevelopment Agency 1997). Therefore, soil RAOs are developed based on human health receptors.

The HHRA for Parcel D evaluated risk associated with each redevelopment block's planned reuse and associated exposure scenarios. The three exposure scenarios applicable to the planned reuse for each redevelopment block at Parcel D are industrial, recreational, and residential. In addition, the construction worker exposure scenario was evaluated for Parcel D. The HHRA results showed that the principal threats to human health from soil under these future land use scenarios come from the ingestion, dermal contact, and inhalation exposure pathways.

4.1.1.1 Chemicals of Concern in Soil

The HHRA for Parcel D presents the potential risks for exposure to surface soils and subsurface soils based on planned reuse separately in Figures 3-5 and 3-6, respectively. Figure 3-7 presents the potential risks for the construction worker exposure scenario. The HHRA results in Appendix B indicate two COC analytical groups that drive the risk at Parcel D: (1) metals and (2) PAHs. Figure 4-1 presents those grids that present a potential unacceptable risk from exposure to either surface or subsurface soils for the planned reuse, and indicates which COC analytical group (metals or PAHs) is the primary risk driver in those grids. Where a grid presents a potential unacceptable risk and overlaps more than one redevelopment block, COCs and remediation goals for those grids are appropriately assigned to the redevelopment block that contains the samples with the COCs that cause the potential unacceptable risk.

Figure 4-1 shows the risk grids where metals are the COC (blue colored grids) that cause cancer risks greater the 1×10^{-6} or the highest segregated HI is greater than 1. As shown on Tables 3-11 and 3-12, the COCs for these grids are arsenic and manganese. This figure also shows a red star where lead is a COC. Figure 4-1 also shows the risk grids where PAHs are the COC (green colored grids) that cause cancer risks greater than 1×10^{-6}. As shown on Tables 3-11 and 3-12, the COCs for these grids are benzo(a)pyrene and benzo(b)fluoranthene. Figure 4-1 shows green grids with a cross-hatch pattern where both PAHs and metals are COCs.

A summary of each COC identified as presenting potential unacceptable risk and their respective remediation goals are presented below by planned reuse. The COCs for the construction worker are also presented. These COCs and remediation goals form the basis for the soil RAOs presented later in this section. The remediation goals for these COCs based on planned reuse are the following:

Planned Reuse	Chemical of Concern in Soil	Remediation Goal
Educational/cultural, industrial, and maritime/industrial	Arsenic	11.1 mg/kg
	Lead	800 mg/kg
	Benzo(a)pyrene	0.33 mg/kg
	Benzo(b)fluoranthene	1.76 mg/kg
Open space (recreational)	Arsenic	11.1 mg/kg
	Benzo(a)pyrene	0.33 mg/kg
Mixed use	Manganese	1,431 mg/kg
Construction worker[1]	Arsenic	11.1 mg/kg
	Lead	800 mg/kg
	Manganese	6,889 mg/kg
	Benzo(a)pyrene	0.65 mg/kg

Note:

1 The construction worker exposure scenario is not associated with a specific planned reuse for Parcel D.

4.1.1.2 Remedial Action Objectives for Soil by Exposure Pathways

The following RAOs apply to Parcel D soil:

1. Prevent exposure to organic and inorganic compounds in soil above the remediation goals developed in the HHRA in Section 3.0 for carcinogens or noncarcinogens for the following exposure pathways:

   - Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 10 feet bgs by residents in areas zoned for mixed use reuse
   - Ingestion of homegrown produce by residents in areas zoned for mixed-use reuse
   - Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to10 feet bgs by industrial workers in areas zoned for educational, cultural, industrial, and maritime industrial reuse
   - Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 2 feet bgs by recreational users in areas zoned for open space reuse
   - Soil ingestion, outdoor air inhalation, and dermal exposure to soil from 0 to 10 feet bgs by construction workers in all areas

2. Prevent exposure to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors. Remediation goals for soil gas will be established during the RD.

4.1.2 Remedial Action Objectives for Groundwater

RAOs for Parcel D groundwater were evaluated based on (1) human health risks through the inhalation of VOCs in indoor air (vapor intrusion) from the A-aquifer groundwater, (2) human health risks through the domestic use exposure pathway from the B-aquifer, (3) human health risks to construction workers from dermal exposure and inhalation, and (4) potential migration to the Bay of COCs at concentrations above surface water criteria. Section 4.1.2.1 discusses the plumes and COCs at Parcel D, and Sections 4.1.2.2 and 4.1.2.3 discuss the RAOs for protection of human health and protection of the environment, respectively.

4.1.2.1 Groundwater Plumes and Chemicals of Concern

The potential groundwater risks for Parcel D from the exposure to VOCs in the A-aquifer through the vapor intrusion pathway are described in the HHRA summary in Section 3.0 and shown on Figure 3-8. The potential groundwater risk to the construction worker is shown on Figure 3-9. As discussed in Section 3.2, VOCs in groundwater were not found to pose a risk to the Bay. Chromium VI and nickel in the A-aquifer are included as COCs because of their potential threat to the Bay. The nature and extent of groundwater contamination for Parcel D based on interpretation of the 2004 groundwater data is shown for chromium VI and nickel on Figure 2-29 and for VOCs on Figure 2-30, and are discussed in Section 2.5.

Figure 4-2 shows the A-aquifer risk plumes derived for the HHRA. Figure 4-2 also shows both VOC plumes and chromium VI plumes and the area of elevated nickel detections in groundwater as discussed in Section 3.2.

All of the VOC, chromium VI, and nickel impacted groundwater are in the A-aquifer. The B-aquifer was evaluated in the HHRA in Appendix B for domestic use exposure scenarios; however, the concentrations of the COPCs did not yield an unacceptable risk.

Three risk plumes were evaluated at Parcel D: IR09, IR-33, IR-71 (see Figure 3-8). Table 3-14 lists the COCs for each plume. The remediation goals are listed by planned reuse below.

Planned Reuse	Chemical of Concern in Groundwater	Remediation Goal
Educational/cultural, industrial, and maritime/industrial	Benzene	0.63 µg/L
	Carbon Tetrachloride	0.5 µg/L
	Chloroform	1.2 µg/L
	Naphthalene	6.0 µg/L
	Tetrachloroethene	1.0 µg/L
	Trichloroethene	4.8 µg/L
	Total Xylenes	337 µg/L
Mixed reuse	Chloroform	1.0 µg/L
	Methylene chloride	27 µg/L
	Trichloroethene	2.9 µg/L
Construction worker[1]	Arsenic	40 µg/L
	Benzene	17 µg/L
	Naphthalene	17 µg/L
	Tetrachloroethene	18 µg/L
	Total Xylenes	861 µg/L

Notes:

1 The construction worker exposure scenario is not associated with a specific planned reuse for Parcel D.

The more conservative goals will be applied in the case where a plume crosses a reuse boundary. The trigger levels for chromium VI and nickel apply at the surface water in the Bay at the interface of the A-aquifer groundwater and the Bay. Groundwater migration is modeled in Appendix G to derive plume-specific attenuation factors to conservatively predict the potential impacts of chromium VI and nickel to the Bay. Based on the results of the modeling, trigger level values for these COCs are developed in Appendix I and presented in Section 3.3.4.1. These trigger levels depend on the plume location, distance from the Bay, and width of the source plume.

4.1.2.2 Groundwater Remedial Action Objectives for the Protection of Human Health

Exposure to VOCs in indoor air through the vapor intrusion pathway under both the residential and industrial exposure scenarios presents a potential unacceptable risk in some areas of Parcel D (see Section 3.0 and Appendix B). Vapor intrusion is not applicable in open space areas because it applies only to indoor air. As a result, the following RAO applies to groundwater at Parcel D:

- Prevent exposure to VOCs in A-aquifer groundwater above remediation goals via indoor inhalation of vapors from groundwater.

The A-aquifer is not considered a domestic use aquifer, and as a result, exposure to COCs via domestic use of groundwater is not a potentially complete pathway (see Section 2.2.9). The B-aquifer was assessed for potential domestic use exposure pathways (see Section 3.0 and Appendix B) and determined to present no human health risk. Under CERCLA, the Navy is not required to take action to prevent hypothetical exposures based on future scenarios that are not reasonably anticipated. However, to assure that the domestic use pathway remains incomplete, the following RAOs will be applied:

- Prevent direct exposure to the groundwater that may contain COCs through the domestic use pathway.

Although risks from exposure to metals and VOCs in groundwater are within an acceptable range for construction workers at Parcel D, the following RAO applies to groundwater at Parcel D:

- Prevent or minimize exposure to metals and VOCs in the A-aquifer groundwater from dermal exposure and inhalation of vapors from groundwater by construction workers above remediation goals.

4.1.2.3 Groundwater Remedial Action Objectives for the Protection of the Environment

The current chromium VI and VOC plumes at Parcel D do not reach the Bay. Similarly, the elevated concentrations of nickel are only present inland. However, chromium VI and nickel were identified as COCs because of their potential threat to the Bay based on concentrations in groundwater that exceed surface water criteria. As a result, the following RAO was developed to address the potential migration of contaminated groundwater in the A-aquifer into the Bay that could affect the surface water:

- Prevent or minimize migration of chromium VI and nickel to prevent discharge that would result in concentrations of chromium VI above 50 micrograms per liter (μg/L) and nickel at concentrations above 96.5 μg/L in the Bay.

4.2 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section (§) 121(d)(l) of CERCLA requires remedial actions attain (or the decision document must justify the waiver of) ARARs, which include environmental regulations, standards, or criteria, promulgated under federal or more stringent state laws. An ARAR may be either applicable or relevant and appropriate, but not both.

> Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically include a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.
>
> Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site (relevant) that their use is well suited (and appropriate) to the particular site.

CERCLA § 121(e) exempts any response action conducted entirely on site from having to obtain a federal, state, or local permit when the action is carried out in compliance with § 121. In addition, on-site actions need only comply with the substantive aspects of ARARs, not with the corresponding administrative procedures, such as administrative reviews and record-keeping requirements. Off-site actions must comply with all legally applicable requirements, both substantive and administrative.

The identification of ARARs is based on a number of site-specific factors, including potential remedial actions, chemicals and compounds found at the site, physical characteristics of the site, and the location of the site. ARARs are usually divided into three categories: chemical-specific, location-specific, and action-specific.

EPA guidance recommends that the lead federal agency, the Navy, consult with the state when identifying state ARARs for remedial actions (EPA 1988). CERCLA and NCP requirements (40 CFR § 300.515) for remedial actions state that the lead federal agency will request that the state identify chemical- and location-specific state ARARs after completion of site characterization. The requirements also provide that the lead federal agency request identification of all categories of state ARARs (chemical-, location-, and action-specific) upon completion of identification of remedial alternatives for detailed analysis. The state must respond within 30 days of receipt of the lead federal agency requests. In a letter dated June 2004, the Navy requested state ARARs from DTSC, the Water Board, and San Francisco Bay Conservation and Development Commission for Parcel D. The Navy received responses to its ARARs request letter from these state agencies in June and July 2004. To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be (1) a standard, requirement, criterion, or limitation under a state environmental or facility siting law; (2) promulgated (of general applicability and legally enforceable); (3) substantive (not procedural or administrative); (4) more stringent than the federal requirement; (5) identified by the state in a timely manner; and (6) consistently applied. Requirements identified by these state agencies that the Navy identified as potential ARARs are described in detail in Appendix C.

This section summarizes potential federal and state of California ARARs for Parcel D. Section 4.2.1 summarizes potential chemical-specific ARARs; Section 4.2.2 summarizes potential location-specific ARARs; and Section 4.2.3 summarizes potential action-specific ARARs. The action-specific discussion is based on the remedial alternatives developed and described in Section 5.0 of this FS. Appendix C discusses the evaluation of ARARs in detail.

4.2.1 Potential Chemical-Specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical cleanup values. Tables in Appendix C summarize the potential chemical-specific ARARs.

4.2.1.1 Soil

There are potential federal and state chemical-specific ARARs for any remedial alternative that will generate waste, such as excavation and off-site disposal of soil. The potential federal chemical-specific ARARs are the substantive provisions of the RCRA requirements at *California Code of Regulations* (Cal. Code Regs.), Title 22 [tit.], §§ 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100, which define RCRA hazardous waste. The potential state chemical-specific ARARs are the substantive provisions of Cal. Code Regs. tit. 22, §§ 66261.22(a)(3) and (a)(4), 66261.24(a)(2) through (a)(8), 66261.101, 66261.3(a)(2)(C) and (a)(2)(F), which define a non-RCRA, state-regulated hazardous waste. If the Navy determines that waste it generates is RCRA hazardous waste or non-RCRA, state-regulated hazardous waste, the Navy will comply with all applicable requirements for proper off-site disposal, such as packaging, manifesting, and land disposal restrictions. Other potential state chemical-specific ARARs are the substantive provisions of Cal. Code Regs., tit. 27, §§ 20210, 20220, and 20230, which define designated, nonhazardous, and inert waste.

4.2.1.2 Groundwater

Using federal and state water quality criteria and site-specific factors identified for the A-aquifer, the Navy has determined that groundwater in the A-aquifer is not a potential drinking water source. The Water Board has concurred in this determination (Water Board 2003). Therefore, drinking water standards, such as MCLs, are not potential chemical-specific ARARs for the A-aquifer. The potential federal chemical-specific ARARs for the A-aquifer are the RCRA groundwater protection standards at Cal. Code Regs. tit. 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e). The lowest concentration limit greater than background that is technically and economically achievable for the A-aquifer is a concentration based on risk posed through the vapor intrusion pathway. The Navy used this potential ARAR to develop remediation goals for the A-aquifer that are protective of the vapor intrusion pathway.

Using the same federal and state water quality criteria and site-specific factors identified for the B-aquifer, discussed in detail in Appendix D, the Navy considers the B-aquifer to have a low potential for use as a drinking water source. No organic chemicals in the B-aquifer exceed MCLs, and the results of the HHRA concluded that there are no COCs and there is no unacceptable risk from the B-aquifer under a residential scenario that included its use as drinking water. Therefore, no groundwater remedial action is necessary for the B-aquifer, and MCLs do not need to be identified as potential ARARs.

The Navy has also accepted the substantive provisions of the following potential state chemical-specific ARARs for both the A-aquifer and the B-aquifer at HPS Parcel D:

- SWRCB Resolution 88-63, for identifying a potential source of drinking water under state criteria
- Chapters 2 and 3 of the Basin Plan, including beneficial use, water quality objectives, and waste discharge requirements, except the municipal and domestic supply designation for the A-aquifer
- *California Water Code* §§ 13240, 13241, 13243, 13263(a), 13269, and 13360 of the Porter-Cologne Act as enabling legislation as implemented through the beneficial uses, water quality objectives, waste discharge requirements, and promulgated policies of the Basin Plan

In addition, the groundwater alternatives may generate waste in the construction of new groundwater wells. This waste will be characterized for off-site disposal according to the potential chemical-specific ARARs discussed in Section 4.2.1.1.

4.2.1.3 Surface Water

There is no surface water body on HPS Parcel D. Groundwater at HPS Parcel D has the potential to discharge to the Bay. The Navy has identified the California Toxics Rule as potential federal chemical-specific ARARs and has accepted Table 3-3 as potential state chemical-specific ARARs for the interface of the A-aquifer groundwater and the Bay. In this revised FS report, the Navy is evaluating groundwater monitoring as a component of groundwater Alternatives GW-2, GW-3A, GW-3B, GW-4A, and GW-4B. This will allow the Navy to monitor any direct release of contamination to the Bay.

The Navy has not identified the California Toxics Rule or accepted Table 3-3 of the Basin Plan as potential ARARs for the B-aquifer because no response action is necessary for groundwater in the B-aquifer. Concentrations of chemicals in the B-aquifer do not exceed even MCLs (which would be protective of the groundwater discharge to surface water pathway) or HGALs.

4.2.2 Potential Location-Specific ARARs

The potential location-specific ARARs for HPS Parcel D are the National Historic Preservation Act, the Coastal Zone Management Act, the McAteer-Petris Act, the authorizing legislation for the San Francisco Bay Conservation and Development Plan (hereafter referred to as the "Bay Plan"), and the Bay Plan.

The Navy identified the 450-ton bridge crane at the Regunning Pier (IR-32) as a structure that had the potential for inclusion on the National Register of Historic Places. Therefore, the Navy has identified the substantive provisions of the National Historic Preservation Act of 1966 (Title 16 U.S.C. §§ 470–470x-6, and its implementing regulations [36 CFR Part 800]) as a potential ARAR. The remedial alternatives evaluated in this revised FS will not affect the 450-ton bridge crane. This FS report documents the Navy's finding that no historic property is affected.

Portions of HPS Parcel D are within 100 feet of the shoreline; however, the Coastal Zone Management Act (16 U.S.C. §§ 1451–1464) specifically excludes federal lands from the definition of coastal zone (16 U.S.C. § 1453[1]). Therefore, the Coastal Zone Management Act is not applicable to HPS Parcel D. The Coastal Zone Management Act was evaluated and determined to be a potentially relevant and appropriate requirement because some of the alternatives evaluated in this FS contemplate activity within the 100 feet of the shoreline. Coastal Zone Management Act § 1456(c)(1)(A) requires each federal agency activity within or outside the coastal zone that affects any land or water use or natural resource to conduct its activities in a manner that is consistent to the maximum extent practicable with enforceable policies of approved state management policies. The State of California's approved coastal management program includes the McAteer-Petris Act, the authorizing legislation for the Bay Plan, and the San Francisco Bay Plan developed by the Bay Conservation and Development Commission; the substantive provisions of both are potential state ARARs.

4.2.3 Potential Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations for remedial activities. These requirements are triggered by the particular remedial activities conducted at the site and indicate how a selected remedial alternative should be achieved.

4.2.3.1 Potential Action Specific ARARs for Soil Alternatives

Remedial alternatives evaluated for Parcel D soil include the following types of actions, as discussed in more detail in Section 5.0: (1) institutional controls; (2) maintained landscaping, (3), excavation and off-site disposal; and (4) covering portions of the site with soil, concrete, or asphalt covers. The following discussion summarizes potential ARARs for these actions.

Institutional Controls

Institutional controls are evaluated in all remedial alternatives for soil except the no action alternative. The specific institutional control objectives are included in Section 5.0 with the discussion of each alternative.

There are no potential federal action-specific ARARs for institutional controls. The Navy accepts the substantive provisions of the following as potential state action-specific ARARs for institutional controls:

- California Civil Code §1471 – which allows property owners to make a hazardous material covenant that runs with the land.
- California Health and Safety Code § 25202.5 – which allows DTSC to enter into agreements with property owners to restrict the use of the property.
- California Health and Safety Code § 25222.1 – which provides the authority for DTSC to enter into agreements with property owners to restrict the use of the property.
- California Health and Safety Code § 25232(b)(1)(A) through (b)(1)(E) – which prohibits certain residential uses of the land without a specific variance.
- California Health and Safety Code § 25233(c) – which provides criteria for obtaining variances from land use restrictions.
- California Health and Safety Code § 25234 – which provides criteria for removing land use restrictions.

- California Health and Safety Code § 25355.5(a)(1)(C) – which provides the authority for DTSC to execute and record a written instrument imposing an easement, covenant, restriction, or servitude, as appropriate, upon the present and future uses of the land.

- Cal. Code Regs. tit. 22, § 67391.1 – which requires DTSC and the federal government execute an appropriate land use covenant that is recorded in the county in which the land is located.

Maintained Landscaping

The substantive provisions of the following requirement is a potential state ARAR for covering soil excavations in areas of naturally occurring asbestos:

- Toxic control measures for airborne asbestos during construction, grading, quarrying, and surface mining operations at Cal. Code Regs. tit 17 § 93105.

Pursuant to Cal. Code Regs. tit. § 93105(e)(4)(G), when construction is complete in areas of naturally occurring asbestos, the disturbed surfaces must be stabilized using one or more of the following methods:

- A vegetative cover

- Placement of at least 3 inches of non-asbestos-containing material

- Paving

- Any other measure deemed adequate to prevent wind speeds of 10 miles per hour or greater from causing visible dust emissions

The maintained landscaping will comply with this potential ARAR.

Excavation and Off-Site Disposal

The Navy has identified the substantive provisions of the following potential federal and state ARARs for excavation in preparation for off-site disposal of soil and any waste, including investigation-derived waste, generated in implementing the soil or groundwater alternatives:

- Cal. Code Regs. tit. 22, § 66262.10(a) and 66262.11 – which requires a generator to determine if generated waste is hazardous waste.

- Cal. Code Regs. tit. 22, § 66264.13(a) and (b) – which requires analysis of waste to determine if it is hazardous.

- 40 CFR § 264.554 (d)(1)(i) through (ii), (d)(2), (e), (f), (h), (i), (j), and (k) – which allows the temporary staging of RCRA hazardous waste in piles.

- Cal. Code Regs. tit. 27, § 20200(c) – requires accurate characterization of wastes.

- Cal. Code Regs. tit. 27, § 20210 – requires the discharge of designated waste to Class I or Class II waste management units.

- Cal. Code Regs. tit. 27, § 20220(b), (c), and (d) – requires the discharge of nonhazardous solid waste to classified units.

- Cal. Code Regs. tit. 27, § 20230(b) – inert wastes do not need to be discharged at classified units.

- Bay Area Air Quality Management District Regulation 6-302 – prohibits source emissions that equal or exceed 20 percent opacity.

Covering the Soil

The Navy has identified the substantive provisions of the following potential federal and state action-specific ARARs for construction of a soil, asphalt or concrete cover:

- Cal. Code Regs. tit. 22, § 66264.310(a)(5) – which requires that a final cover accommodate lateral and vertical shear forces generated by the maximum credible earthquake.

- Cal. Code Regs. tit. 22, § 66264.310(b)(1) and (b)(4) – which requires controls for final cover maintenance and final cover run-on and run-off.

- Cal. Code Regs. tit. 22, § 66264.310(b)(5) – which requires maintenance of survey benchmarks.

- Cal. Code Regs. tit. 27, § 20080(b) – which allows engineered alternatives to the prescriptive final cover standards.

- Cal. Code Regs. tit. 27, § 20090(d) – which requires public agencies to comply with Cal. Code Regs. tit. 27 to the extent feasible when taking action to clean up unauthorized releases.

- Cal. Code Regs. tit. 27, § 20950(d) – which requires installation of permanent monuments.

- Cal. Code Regs. tit. 27, § 21090(b)(1) – which presents final cover design, grading, and maintenance requirements.

- Cal. Code Regs. tit. 27, § 21090(c)(4) – which requires erosion control and damage prevention for covers.

- Cal. Code Regs. tit. 27, § 21090(e)(1) and (e)(3) – which requires an aerial photographic or alternative survey.

- Cal. Code Regs. tit. 27, § 21140 – which presents final cover and alternative final cover standards.

- Cal. Code Regs. tit. 27, § 21145(a) – which presents final slope requirements.

- Cal. Code Regs. tit. 27, § 21150 – which requires drainage and erosion control for covers.

- Bay Area Air Quality Management District Regulation 6-302 – which prohibits source emissions that equal or exceed 20 percent opacity.

- Clean Water Act § 402 and its implementing regulations at 40 CFR § 122.44(k)(2) and (4) – which requires best management practices for storm water discharge resulting from construction activities that will disturb 1 or more acres. (The Navy will use the State of California storm water general permit, Order Number 99-08-DWQ as to-be-considered guidelines for complying with this potential federal ARAR.)

4.2.3.2 Potential Action Specific ARARs for Groundwater Alternatives

Remedial alternatives evaluated for Parcel D groundwater include the following types of actions: (1) groundwater monitoring, (3) *in situ* treatment, and (2) institutional controls, as discussed in more detail in Section 5.0. The potential action-specific ARARs for these processes are discussed below.

Groundwater Monitoring

The Navy has identified the substantive provisions of the following potential federal and state ARARs for the long-term monitoring:

- Cal. Code Regs. tit. 22, § 66264.90(c) – which allows a shorter monitoring period when wastes remain in place than required under Cal. Code Regs. tit. 22, § 66264.117 based on compliance with remediation goals for a period of 3 consecutive years.

- Cal. Code Regs. tit. 22, § 66264.91(a)(1) – which requires a detection monitoring program.

- Cal. Code Regs. tit. 22, § 66264.93 – which requires identification of constituents of concern.

- Cal. Code Regs. tit. 22, § 66264.97(b)(1)(A), (b)(1)(B), (b)(1)(C), (b)(1)(D)(1) and (b)(1)(D)(2) – which present general groundwater monitoring requirements. .

- Cal. Code Regs. tit. 22, § 66264.97(b)(4), (5), (6), and (7) – which presents monitoring well construction requirements.

- Cal. Code Regs. tit. 22, § 66264.97(e)(6), (e)(12)(A), (e)(12)(B), (e)(13), and (e)(15) – which present general monitoring system requirements .

- Cal. Code Regs. tit. 22, § 66264.98(e)(1) through (e)(5), (i), (j), (k)(1) through (k)(3), (k)(4)(A), (k)(4)(D), (k)(5), (k)(7)(C), (k)(7)(D), (n)(1), (n)(2)(b), and (n)(2)(C) – which present requirements for detection monitoring.

- Cal. Code Regs. tit. 22, § 666264.99(b), (e)(1) through (6), (f)(3), (g) – which present requirements for evaluation monitoring.

- Cal. Code Regs. tit. 22, § 66264.100(d) – which requires a corrective action monitoring program that demonstrates the effectiveness of the corrective action program.

- Cal. Code Regs. tit. 22, § 66264.100(g)(1) – which requires continued corrective action monitoring until compliance with remediation goals for 1 year is demonstrated.

- Cal. Code Regs. tit. 22, § 66264.117(b)(2)(A) – which allows for a shortened postclosure care period when the reduced period is sufficient to protect human health and the environment.

- Cal. Code Regs. tit. 27, § 20090(d) – which requires that public agencies comply with Title 27 to the extent feasible when taking action to clean up unauthorized releases.

In addition, the potential ARARs identified in Section 4.2.3.1 for disposal of investigation derived waste would also be potential ARARs for any investigation derived waste generated in constructing the groundwater monitoring program.

***In Situ* Treatment**

Under this alternative, the Navy will inject substrates into the groundwater to actively treat contaminants where concentrations are the highest.

The Navy has identified 40 CFR § 144.12 as a potential federal action-specific ARAR under the Underground Injection Control Program of the Safe Drinking Water Act, which prohibits constructing, operating, maintaining, converting, plugging, abandoning, or conducting any other injection in a manner that allows movement of fluid containing any contaminant into underground sources of drinking water. The *in situ* treatment for the A-aquifer contemplated under this alternative would not cause any contaminated fluid to move into the B-aquifer or any other underground source of drinking water.

Institutional Controls

Specific institutional control objectives are discussed in Section 5.0 with the discussion of each groundwater remedial alternative that may include institutional controls. Potential ARARs identified in Section 4.2.3 are also potential ARARs for the groundwater institutional controls.

4.3 GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS ANALYSES

GRAs are categories of actions that are made up of specific process options. These GRAs are responses or remedies that will meet the RAOs to protect human health and the environment from the known contamination at Parcel D. Process options are specific technologies used to carry out a GRA. Section 4.3.1 describes the GRAs for Parcel D soil and groundwater, and Section 4.3.2 presents the results of the analysis for the proposed GRAs.

4.3.1 Development of General Response Actions

GRAs were derived from engineering judgment and past experience with remedial actions proven to be successful for the applicable COCs at Parcel D. Because the RAOs were developed based on the planned future land use, the GRAs were also developed considering the planned future land use of each redevelopment block. The GRAs for Parcel D and their respective process options are presented in Table 4-1 for soil and in Table 4-2 for groundwater. The following GRAs were identified to ensure that the soil and groundwater RAOs are met.

Soil

- No action – Required GRA for CERCLA evaluation
- Removal – Includes passive venting, excavating and off-site disposal of excavated soils as well as off-site disposal of stockpiled soil
- Treatment – Includes *in situ* and *ex situ* treatment of soils to reduce the toxicity of the contaminants
- Containment – Includes covering contaminated soils to break the direct exposure pathway
- Institutional controls – Includes legal and administrative mechanisms to restrict land use, and
- Access restrictions – Includes physical barriers such as fences and informational devices such as warning signs

Groundwater

- No action – Required GRA for CERCLA evaluation
- Treatment – Includes *in situ* and *ex situ* treatment of contaminated groundwater
- Removal – Includes pumping to remove the groundwater prior to disposal
- Containment – Includes installing slurry wall to control groundwater flow
- Institutional controls – Includes legal and administrative mechanisms to restrict groundwater use
- Access restrictions – Includes physical barriers such as fences and informational devices such as warning signs

Process options for these GRAs are evaluated below in Section 4.3.2.

4.3.2 Analysis of General Response Actions and Process Options

GRAs selected for this revised FS report underwent an initial screening and a subsequent detailed analysis. During the initial screening, the range of technology types and process options are evaluated with respect to technical implementability, site conditions, waste characteristics, contaminant properties, and the ability to meet NCP requirements and RAOs. The initial screening results are summarized in Tables 4-1 and 4-2 for soil and groundwater, respectively. Those GRAs and process options that were carried forward from the initial screening are then analyzed with respect to effectiveness, implementability, and cost. Table 4-3 summarizes the results of this detailed analysis. The screening and analysis of GRAs and process options is presented separately for soil and groundwater. Section 4.3.2.1 presents the analysis for the applicable soil process options, and Section 4.3.2.2 presents the analysis for the applicable groundwater process options.

4.3.2.1 Evaluation of Applicable Soil Process Options

Potentially applicable GRAs identified for soil at Parcel D consist of (1) no action, (2) institutional controls, (3) removal, (4) treatment, and (5) containment. The initial screening of process options for the remedial technology types for these soil GRAs is shown in Table 4-1. This table presents the various technology types, process options, and screening analysis results for each soil GRA. The rationale for those options eliminated from further evaluation is presented in Table 4-1; these options are not discussed further.

Four GRAs are retained for further evaluation including no action. The fifth GRA, treatment, was eliminated during the initial screening of process options for soil at Parcel D. Several treatment options were considered for the COCs in soil. However, none of the treatment options are implementable for ubiquitous metals that are present in bedrock-derived fill material at

Parcel D at concentrations above remediation goals. For the relatively small volumes associated with the remaining COCs (lead and PAHs), treatment is not as cost-effective or as implementable as excavation.

Those process options retained during the initial screening were evaluated for effectiveness, implementability and cost and are discussed in this section. Table 4-3 summarizes the results for this evaluation.

No Action

The NCP requires that the no-action alternative be carried through the detailed analysis of alternatives. Under the no-action response, no remedial action is taken. Soil would be left as is without implementing any institutional controls, containment, removal, treatment, or other mitigating actions. Because soil at Parcel D poses a risk to human health and the environment under the anticipated future land use scenario, the no-action response would not be an effective alternative that meets the requirements of CERCLA. Because no action is taken, no cost is associated with this option. The no action option will be retained for further evaluation as a remedial alternative for comparison purposes only, as required under the NCP.

Institutional Controls in General

Institutional controls are legal and administrative mechanisms used to implement land use and access restrictions that are used to limit the exposure of future landowner(s) and/or user(s) of the property to hazardous substances present on the property, and to ensure the integrity of the remedial action. Institutional controls are required on a property where the selected remedial cleanup levels result in contamination remaining at the property above levels that allow for unlimited use and unrestricted exposure. Institutional controls would likely remain in place unless the remedial action taken would allow for unrestricted use of the property. Implementation of institutional controls includes requirements for monitoring and inspections, and reporting to ensure compliance with land use or activity restrictions.

Legal mechanisms include proprietary controls such as restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting, or other existing land use management systems that are intended to ensure compliance with land use or activity restrictions.

The Navy has determined that it will rely upon proprietary controls in the form of environmental restrictive covenants, as provided in the "Memorandum of Agreement Between the United States Department of the Navy and the California Department of Toxic Substances Control" and attached covenant models (Navy and DTSC 2000) (hereinafter referred to as the "Navy/DTSC MOA"). Appendix J contains the Navy/DTSC MOA.

More specifically, land use and activity restrictions will be incorporated into two separate legal instruments as provided in the Navy/DTSC MOA:

1 Restrictive covenants included in one or more Quitclaim Deeds from the Navy to the property recipient.

2 Restrictive covenants included in one or more "Covenant to Restrict Use of Property" entered into by the Navy and DTSC as provided in the Navy/DTSC MOA and consistent with the substantive provisions of Cal. Code Regs. tit. 22 § 67391.1.

The "Covenant(s) to Restrict Use of Property" will incorporate the land use restrictions into environmental restrictive covenants that run with the land and that are enforceable by DTSC against future transferees. The Quitclaim Deed(s) will include the identical land use and activity restrictions in environmental restrictive covenants that run with the land and that will be enforceable by the Navy against future transferees.

The activity restrictions in the "Covenant(s) to Restrict Use of Property" and Deeds shall be implemented through the Parcel D Risk Management Plan ("Parcel D RMP") to be prepared by the City of San Francisco and approved by the Navy and FFA Signatories. The Parcel D RMP shall be discussed in the Parcel D ROD and shall be attached to and incorporated by reference into the Covenant(s) to Restrict Use of Property and Deeds as an enforceable part thereof. It shall specify soil and groundwater management procedures for compliance with the remedy selected in the Parcel D ROD. The Parcel D RMP shall identify the roles of local, state, and federal government in administering the Parcel D RMP and shall include, but not be limited to, procedures for any necessary sampling and analysis requirements, worker health and safety requirements, and any necessary site-specific construction and/or use approvals that may be required.

In addition to being set forth in the Covenant and Deed(s) as described above, restrictions applied to specified portions of the property will be described in findings of suitability for transfer and findings of suitability for early transfer.

Access

The Deed and Covenant shall provide that the Navy and FFA Signatories and their authorized agents, employees, contractors and subcontractors shall have the right to enter upon HPS Parcel D to conduct investigations, tests, or surveys; inspect field activities; or construct, operate, and maintain any response or remedial action as required or necessary under the cleanup program, including but not limited to monitoring wells, pumping wells, treatment facilities, and cap/containment systems.

Implementation

The Navy shall address/describe institutional control implementation and maintenance actions including periodic inspections and reporting requirements in the preliminary and final RD reports to be developed and submitted to the FFA Signatories for review pursuant to the FFA. (See "Navy Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use

Controls and Other Post-ROD Actions" attached to January 16, 2004 Department of Defense (DoD) memorandum titled "Comprehensive Environmental Response, Compensation and Liability Act [CERCLA] Record of Decision [ROD] and Post-ROD Policy.") The preliminary and final RD reports are primary documents as provided in Section 7.3 of the FFA.

Activity Restrictions that Apply Throughout Parcel D

The following sections describe the institutional control objectives to be achieved through activity restrictions throughout Parcel D in order to ensure that any necessary measures to protect human health and the environment and the integrity of the remedy have been undertaken.

Restricted Activities

The following restricted activities throughout HPS Parcel D must be conducted in accordance with the "Covenant(s) to Restrict Use of Property," Quitclaim Deed(s), the Parcel D RMP, and, if required, any other work plan or document approved in accordance with these referenced documents:

- "Land disturbing activity" which includes but is not limited to: (1) excavation of soil, (2) construction of roads, utilities, facilities, structures, and appurtenances of any kind, (3) demolition or removal of "hardscape" (for example, concrete roadways, parking lots, foundations, and sidewalks), (4) any activity that involves movement of soil to the surface from below the surface of the land, and (5) any other activity that causes or facilitates the movement of known contaminated groundwater.

- Alteration, disturbance, or removal of any component of a response or cleanup action (including but not limited to pump-and-treat facilities, revetment walls and shoreline protection, and soil cap/containment systems); groundwater extraction, injection, and monitoring wells and associated piping and equipment; or associated utilities.

- Extraction of groundwater and installation of new groundwater wells.

- Removal of or damage to security features (for example, locks on monitoring wells, survey monuments, fencing, signs, or monitoring equipment and associated pipelines and appurtenances).

Prohibited Activities

The following activities are prohibited throughout HPS Parcel D:

- Growing vegetables or fruits in native soil for human consumption.

- Use of groundwater.

Activity Restrictions Relating to VOC Vapors at Specific Locations within Parcel D

Any proposed construction of enclosed structures must be approved in accordance with the "Covenant to Restrict Use of the Property," Quitclaim Deed, and Parcel D RMP prior to the conduct of such activity within the area requiring institutional controls (ARIC) for VOC vapors in order to ensure that the risks of potential exposures to VOC vapors are reduced to acceptable levels that are adequately protective of human health. Initially, the ARIC will include all of Parcel D. This can be achieved through engineering controls or other design alternatives that meet the specifications set forth in the ROD, RD reports, land use control (LUC) RD report, and Parcel D RMP. The ARIC may be modified by the FFA Signatories as the soil contamination areas and groundwater contaminant plumes that are producing unacceptable vapor inhalation risks are reduced over time or in response to further soil, vapor, and groundwater sampling and analysis for VOCs that establishes that areas now included in the ARIC do not pose an unacceptable potential exposure risk to VOC vapors.

Additional Land Use Restrictions for Areas Designated Open Space, Educational/Cultural, and Maritime/Industrial

The following restricted land uses for property areas designated for open space, educational/cultural, and maritime/industrial land uses in the "Hunters Point Shipyard Redevelopment Plan" dated July 14, 1997 must be reviewed and approved by the FFA Signatories in accordance with the "Covenants to Restrict Use of the Property," Quitclaim Deed(s), and Parcel D RMP prior to use of the property for any of the restricted uses:

- A residence, including any mobile home or factory built housing, constructed or installed for use as residential human habitation,
- A hospital for humans,
- A school for persons under 21 years of age, or
- A daycare facility for children.

Removal

Removal is an effective process option for all contaminant groups associated with soil at Parcel D and involves removing and transporting contaminated material off site to a permitted treatment and disposal facility. To meet land disposal restrictions, some pretreatment such as stabilization may be required or preferred so that the most economical disposal option can be applied. Important considerations with the removal and disposal process option include excavation volume, fugitive emissions, hauling distance, and type of treatment/disposal facility for final deposition. Excavations will be to a maximum depth of 10 feet for industrial and residential land use and to a maximum depth of two feet for recreational land use. The excavation cleanup criteria would be specific to the reuse type and analyte-specific remediation goals specified in Section 4.1.1.1.

Excavation is effective and implementable for many of the COCs found in soil at Parcel D. Most of the near-surface soil at Parcel D is fill that was placed without documentation. The mineral content in the fill, the locations where the fill was placed, the method of placement, and the concentrations of metals in the fill are not documented. As a result, concentrations of metals above remediation goals (such as arsenic and manganese) are spread throughout Parcel D. Excavation is not practical to address the removal of these ubiquitous metals present at concentrations above remediation goals. Excavation of ubiquitous metals could involve excavating most of Parcel D to 10 feet. In the case of lead, which is detected frequently above the HPAL but infrequently above the remediation goal, excavation is implementable. In addition, these higher concentrations are more likely associated with spills or releases. Excavation of PAHs, which are assumed to be associated with releases, is an effective approach to reach RAOs. Therefore, the excavation process option will be retained for only the lead and PAH contaminated areas that present potential unacceptable risk. For the excavation areas and volumes, the cost is expected to be moderate. Six excavations would be required, with a total anticipated in-place soil volume of 672 cubic yards. For this volume and number of excavations, costs are expected to be moderate. Off-site disposal is also effective for removal of the miscellaneous stockpiles of undocumented soil that are present at Parcel D. The excavation and off-site disposal process options will be retained for development and evaluation of remedial alternatives.

Containment

Containment processes are intended to isolate the contaminated soil to prevent direct exposure and contaminant migration. The most appropriate containment process options for Parcel D are surface covers. Cover materials used to prevent direct exposure may include soil, asphalt or concrete, and the material to be used will depend on the planned reuse associated with each redevelopment block. Covers included in this alternative may include new covers and existing or future building footprints, roads, parking lots, and maintained landscape. These covers function to block exposure to metals in the fill material. The health risk due to arsenic and other metals at concentrations below ambient levels is clearly demonstrated by the HHRA, with the soil ingestion and dermal contact the pathways with the greatest risk. Therefore, the covers and institutional controls that require their maintenance will be effective in preventing exposure.

The general approach for implementing covers includes:

1. Existing asphaltic concrete and cementitious concrete (concrete) surfaces and buildings will be considered existing covers so long as they block the exposure pathway from the soil to the potential surface receptors. Existing asphaltic concrete can be renovated with an asphalt seal coat, and concrete surfaces and building floors can be patched so long as the patches and seals adequately break the pathway. Rehabilitation of existing covers will be designed to meet the same minimum requirements as new covers.

2. Where covers are needed, areas will be covered with a durable material that will not break, erode, or deteriorate such that the underlying soil becomes exposed. Standard construction practices for roads, sidewalks, and buildings would likely be adequate to meet this performance standard. Other examples of covers could include a minimum 4 inches of asphalt, a minimum 2 feet of clean imported soil, and maintained landscaping. All covers must achieve a full cover over the entire redevelopment block. The exact nature and specifications for covers can vary from block to block, but all covers must meet the performance standard of preventing exposure to soil and durability. Covers will protect from exposure to organic and inorganic chemicals in soil as well as potential asbestos in soil.

3. Drainage for asphaltic concrete and concrete covers will be consistent with the adjacent existing covers. Drainage for soil covers will be engineered so as not to promote erosion.

4. All existing or newly installed covers will need to be maintained. Maintenance includes inspections and repairs for covers that are left in place during the future land use and replacement of covers if the future land use requires excavation or demolition of the covers during construction. Any modification of existing hardscape will be subject to the institutional controls described earlier.

5. Sampling requirements associated with disturbance of covers will be in accordance with the RMP.

The process option of covers is effective, so long as the covers are properly installed and maintained, and are replaced after excavations or demolition during redevelopment construction activities. Because most of the areas with the redevelopment blocks at Parcel D have existing covers, the implementability and cost are expected to be moderate. The cover process options will be retained for development and evaluation of remedial alternatives.

4.3.2.2 Evaluation of Applicable Groundwater Process Options

Potentially applicable GRAs identified for groundwater at Parcel D consist of (1) no action, (2) institutional controls, (3) treatment, (4) removal, and (5) containment. The initial screening of process options for the remedial technology types for these groundwater GRAs is shown in Table 4-2. This table presents the various technology types, process options, and screening analysis result for each groundwater process option. Removal and containment of groundwater were not retained following the initial screening due to difficulty of implementation and poor effectiveness. The rationale for those options eliminated from further evaluation is presented in Table 4-2; these options are not discussed further.

Those process options retained during the initial screening are evaluated for effectiveness, implementability and cost and are discussed in this section. Table 4-3 summarizes the results of this evaluation.

No Action

The NCP requires that the no-action alternative be carried through the detailed analysis of alternatives. Under the no-action response, no remedial action is taken. Groundwater would be left as is without implementation of any institutional controls, containment, removal, treatment, or monitoring actions. Because groundwater at Parcel D poses a risk to human health based on the current HHRA, the no-action response would not be an effective alternative that satisfies the RAOs or meets the requirements of CERCLA. Because no action is taken, no cost is associated with this option. The no action option will be retained for further evaluation as a remedial alternative for comparison purposes only, as required under the NCP.

Institutional Controls

Institutional controls as a GRA are discussed in Section 4.3.2.1 under the evaluation of soil process options. In addition, to the requirements and restrictions discussed in Section 4.3.2.1, there are land use restrictions relating to groundwater and associated VOC vapors at specific locations within Parcel D.

The restricted land uses set forth above in Section 4.3.2.1 must be approved by the FFA signatories in accordance with the "Covenant to Restrict Use of the Property," Quitclaim Deed, and Parcel D RMP prior to such use of the property within Parcel D in order to ensure that the risks of potential exposures to VOC vapors are reduced to acceptable levels that are adequately protective of human health. This can be achieved through engineering controls or other design alternatives which meet the specifications set forth in the ROD, RD reports, LUC RD report, and Parcel D RMP. The Parcel D RMP shall provide for adequate soil, vapor, and groundwater sampling and analysis for VOCs. Although the human health exposure risk areas with the greatest risks are within the groundwater contaminant plume and nonplume areas, the restricted land uses will be applied parcel-wide for ease of implementation and as a conservative approach to assure human health protection. The institutional controls and land use restrictions may be modified by the FFA signatories as the groundwater contamination that is producing the unacceptable vapor inhalation risks is reduced over time.

Groundwater Monitoring

Groundwater monitoring is an effective technology for assessing changes in the groundwater quality of chromium VI, nickel, and VOCs. Groundwater monitoring is protective of human health and the environment by detecting potential increases in concentrations or migration of contaminants that could pose unacceptable risk of exposure. Although monitoring does not reduce the mobility, toxicity, or volume of hazardous substances in the groundwater and does not address the RAOs on its own, this process option would be performed in conjunction with other passive or active process options that fulfill these objectives. Monitoring groundwater also provides data on whether plumes are migrating toward the Bay. Reductions in concentrations of VOCs have been observed over time at Parcel D (see Appendices A and E). Groundwater monitoring serves as a stand-alone measure for ongoing evaluation of the incomplete pathways associated with the inland metal plumes. Groundwater monitoring is easy to implement at relatively low cost. Groundwater monitoring will be retained for development and evaluation of remedial alternatives.

Treatment

The contaminated groundwater at Parcel D that poses unacceptable human health risk is only present in the A-aquifer. VOCs are the only COCs for groundwater based on the human health risk, with the exposure pathway from vapor intrusion into indoor air. Chromium VI and nickel are also COCs for groundwater based on the potential for migration to surface water. Table 4-2 provides a first screening of multiple treatment technologies, resulting in two types of treatment technologies that are retained: (1) *in situ* biological treatment, and (2) *in situ* chemical treatment.

In Situ Biological Groundwater Treatment

The *in situ* biological treatment technology type consists of aerobic and anaerobic reaction process options in the aquifer that degrade the dissolved-phase contaminants to less toxic compounds. Since no removal or handling of groundwater is required for these methods, these *in situ* processes tend to be more economical than *ex situ* processes. *In situ* biodegradation is generally performed by injecting into the contaminant plume a nutrient substrate that may be infused with selected microorganisms specific for degrading COCs. This process may also be implemented by injecting only a nutrient substrate to enhance the growth of naturally occurring microorganisms. At HPS, a recent treatability study has demonstrated that the microorganisms needed for *in situ* biodegradation of chlorinated solvent constituents currently are present in groundwater (Shaw Environmental, Inc. 2005).

Under both aerobic and anaerobic process options, the microorganisms metabolize and mineralize the COCs into nontoxic byproducts. Some organisms degrade specific compounds anaerobically, while others degrade compounds aerobically. *In situ* biological groundwater treatments are not effective for extremely high concentrations of VOCs associated with separate-phase products of VOCs, but these processes are very effective for moderate to low concentrations of VOCs found at Parcel D assuming the optimal species and nutrients are applied. Recent studies at HPS have demonstrated that aerobic bioremediation is effective for fuel-related products and for chlorobenzenes and that anaerobic bioremediation is effective for the tetrachloroethene, trichloroethene, and the breakdown products of these chlorinated VOCs, including vinyl chloride (Shaw Environmental, Inc. 2005). Aerobic bioremediation is therefore retained for evaluation.

The anaerobic bioremediation has been shown to be effective for chlorinated COCs. However, not all substrates are directly effective for degrading dissolved concentrations of chromium VI in the groundwater, but these reactions may yield degradation of the chromium VI as a byproduct of the induced reductive groundwater conditions. Remediation products are available that simultaneously remove dissolved metals from groundwater by immobilization and also provide a substrate for biodegradation of chlorinated compounds. The use of a metals treatment substrate containing sulfur that is specifically designed to precipitate chromium VI will reduce chromium VI to chromium III, as well as remove both from the dissolved phase

(Willett and Kroenigsberg 2004). Other metals such as nickel will also be immobilized from the dissolved phase. This type of process is therefore effective for VOCs, chromium VI, and nickel found at Parcel D, and would be effective at both moderate and low concentrations of these contaminants in groundwater. The *in situ* biological groundwater treatment process option is fairly easy to implement as a standard proven technology, and has been found to be implementable at moderate costs. The major challenge to implement *in situ* groundwater treatment technology is to achieve effective mass transfer of the substrate throughout the treatment zone. The anaerobic bioremediation process option will be retained for development and screening of remedial alternatives.

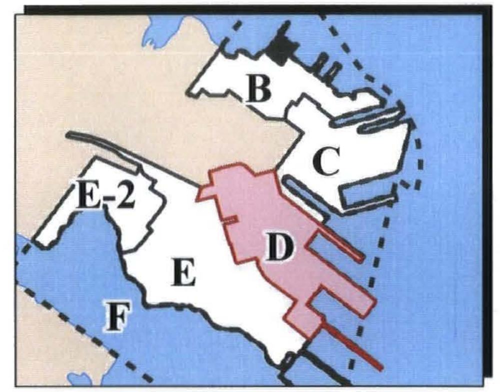
In Situ Chemical Groundwater Treatments

The *in situ* chemical groundwater treatment technology type consists of oxidation and reduction reaction process options in the aquifer that either degrade the dissolved-phase contaminants to less toxic compounds, or precipitate contaminants within the aquifer. As with the *in situ* biological remediation, no removal or handling of groundwater is required. This tends to make these *in situ* processes more economical than *ex situ* processes.

For the VOCs and chromium VI present at Parcel D, a reduction reaction would be most effective. Chemical oxidation is not known to be effective for treating chromium VI (Ground-Water Remediation Technology Analysis Center 1999). Therefore, the oxidation reaction is eliminated and not discussed further.

Chemical degradation through injection of reduction reagents is generally performed by injecting reactive chemicals, such as zero-valent iron (ZVI) or other compounds to create a reduced condition in the aquifer. The injected reagents chemically degrade the contaminants into less toxic byproducts by dechlorinating the VOCs, reducing chromium VI to chromium III, and precipitating the total chromium and nickel out of the dissolved phase in the groundwater. These reactions usually stimulate biodegradation from naturally occurring microorganisms that further enhances the degradation of VOCs. This type of reaction is therefore very effective for the VOCs, chromium VI, and nickel found at Parcel D, and would be effective at both high and low concentrations of these contaminants in groundwater. The *in situ* groundwater treatment process option reduces the mobility, toxicity, or volume of hazardous substances in the groundwater satisfies the RAOs. These treatment process options are fairly easy to implement as a standard proven technology, and have been evaluated to be implementable at moderate to high costs, depending on the type of additives used, the volume of additive needed, and the number of inoculations. As with bioremediation, achieving effective mass transfer of ZVI throughout the treatment zone is a key factor in the successful operation of this technology. The reduction reaction process option will be retained for development and screening of remedial alternatives.

FIGURES



Location Map

★ Industrial Lead Concentration > 800 mg/kg
Road
Cancer Risk > 1E-06 or Highest Segregated Hazard Index > 1 (Metal Driver)
Cancer Risk > 1E-06 (PAH Driver)
Cancer Risk > 1E-06 or Highest Segregated Hazard Index > 1 (PAH and Metal Driver)
Cancer Risk ≤ 1E-06 and Highest Segregated Hazard Index ≤ 1
No Data
Industrial
Research and Development
Mixed Use
Open Space
Maritime Industrial
Educational/Cultural
Parcel Boundary
401 Building
Non-Navy Property
San Francisco Bay

Notes:
1. A 50-foot by 50-foot exposure area (residential grid) is used to evaluate risks associated with Mixed Use and Research and Development planned reuses.
2. A 150-foot by 150-foot exposure area (industrial grid) is used to evaluate risks associated with Industrial, Maritime Industrial, and Educational/Cultural planned reuses.

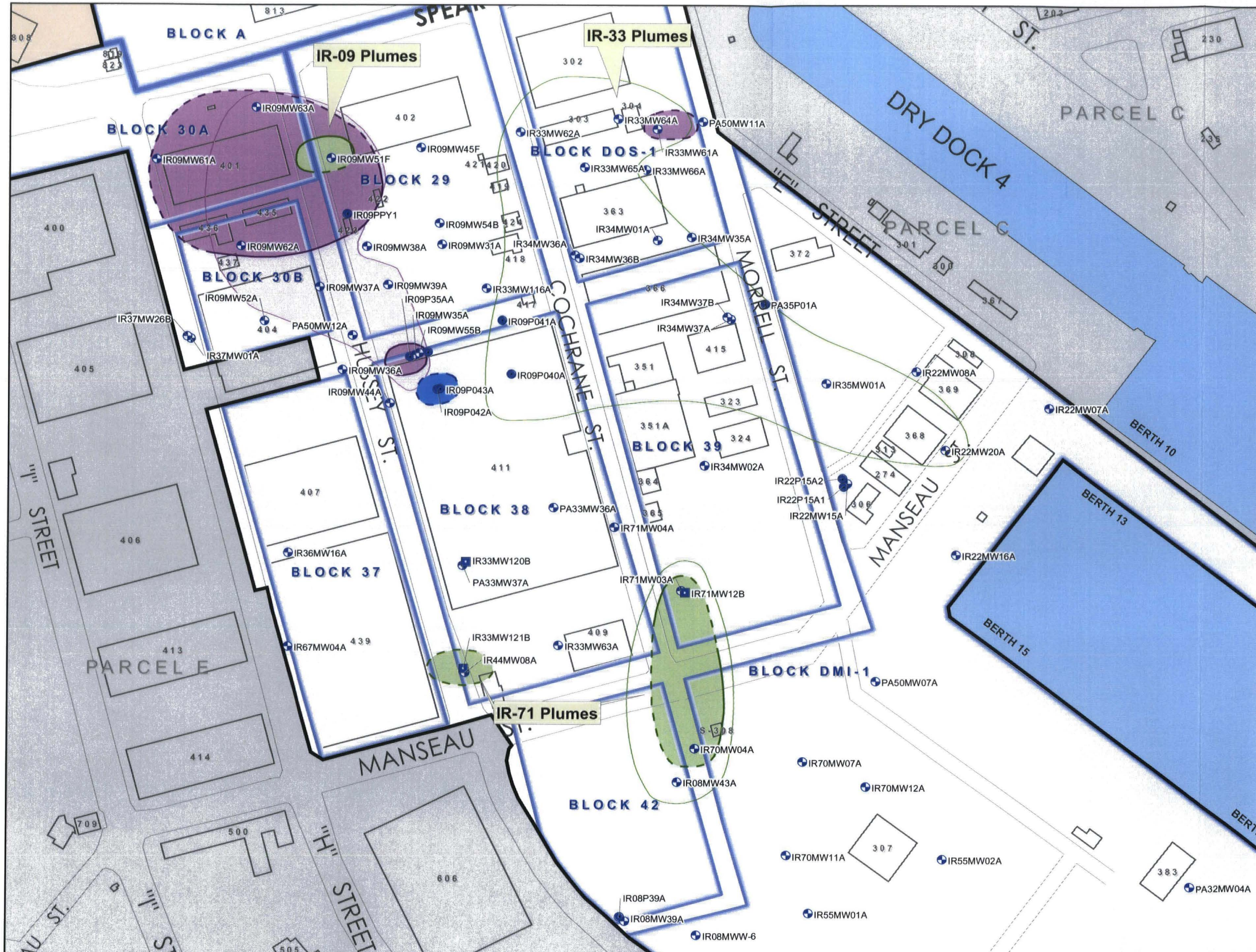
Blk Block
mg/kg Milligram per kilogram
PAH Polynuclear aromatic hydrocarbon

SulTech

Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 4-1
SURFACE AND SUBSURFACE SOIL INCREMENTAL RISK BASED ON PLANNED REUSE
Revised Feasibility Study Report for Parcel D

11/23/2005 O:\Hunters Point\Projects\Parcel_D\Parcel D FS\Figure_4-1.mxd TtEMI-DN Kurt.Cholak



- A-aquifer Well
- B-aquifer Well
- Piezometer

2004 Groundwater Plumes (outline dashed where uncertain)

- Trichloroethene, Tetrachloroethene, and Chloroform
- Chromium VI
- Nickel

Risk Plumes

- Trichloroethene, Tetrachloroethene, and Chloroform
- Trichloroethene, Tetrachloroethene, Chloroform, and Chromium VI
- Parcel D Redevelopment Blocks
- Parcel D Boundary
- Other Parcel Boundaries
- Non-Navy Property
- Building
- Road

Notes:
2004 plumes are based on analytical groundwater data from Quarter 18 (June 2004).
Risk plumes are based on analytical groundwater data collected between Quarter 1 (April 1990) and Quarter 18 (June 2004).

N

200 0 200
Scale in Feet

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FIGURE 4-2
COMPARISON OF THE 2004 GROUNDWATER PLUMES AND RISK PLUMES IN THE A-AQUIFER

Revised Feasibility Study Report for Parcel D

2007-10-15 V:\Hunters_Point\Projects\Parcel_D\FS_2005\Nature and Extent of Contamination\Groundwater\Historical vs 2004 Plumes_11x17.mxd TtEMI-SF Kevin Ernst

TABLES

TABLE 4-1: SCREENING OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Screening Comments
No Action	Not Applicable	Not Applicable	No Action	Retained – Required by NCP
Institutional Controls	Institutional Controls	Land Use Restrictions	Prohibits activities not specified for the designated land use; prohibits growing produce in native soil (EPA 2000a)	Retained – Easily implemented and effective; usually required to restrict activity based on land use
		Covenants to Restrict Use of Property	Restricts the use of the parcel to those reuses that are identified at the time the ROD is signed; includes criteria during and after future development to ensure that mitigated exposure conditions are maintained such as covers, barriers, or other engineering controls (EPA 2000a)	Retained – Easily implemented and effective; usually required to restrict activity based on land use
Access Restrictions	Engineering Controls	Barriers and Signs	Fencing, barriers, and posting signs to restrict land use where there is exposure to potentially contaminated soil (EPA 2000a)	Retained – Easily implemented and effective; usually required to restrict activity based on land use
Removal	Excavation	Conventional Excavation	Excavation of contaminants using conventional mechanical equipment; limit to depths of less than 10 feet bgs	Retained for lead and PAHs – Effective; easily and quickly implemented; permanent remedy; moderate costs
				Eliminated for ubiquitous metals such as arsenic and manganese – Not implementable or cost-effective for entire redevelopment blocks
	Passive Venting	Venting	VOCs in vapor phase are extracted from the soil under low negative pressures, at low rates, and at low concentrations that can usually be released to the atmosphere; Often used in conjunction with vapor barriers or vapor galleries to enhance effectiveness (EPA 1997a)	Eliminated – Mostly effective for VOCs, but VOCs in soil are not COCs at Parcel D
	Off-Site Disposal	Treatment/Disposal Facility	Transport and dispose of soils at a permitted treatment and disposal facility; includes excavated soil to remove COCs from the soil, and existing soil stockpiles that potentially contain COCs	Retained – Effective; Easily and quickly implemented; Permanent remedy; Moderate costs

TABLE 4-1: SCREENING OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL (CONTINUED)
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Screening Comments
Treatment	Biological Treatment	Bioremediation	Reduces contaminants from soil by metabolizing organics with biological amendments (Federal Remediation Technologies Roundtable 2005)	Eliminated – Not effective for metal COCs; not efficient for low volumes of PAH soils at low concentrations
	Physical/Chemical Treatment	Soil Washing	Remove contaminants by exposing soil to an aqueous washing solution in a reactor (Federal Remediation Technologies Roundtable 2005)	Eliminated – Difficult to implement for heterogeneous soils; not implementable for ubiquitous metals or cost-effective for entire redevelopment blocks
		Solidification/ Stabilization	Reduction of contaminant mobility through physical or chemical reaction with stabilizing agents (EPA 1998b)	Eliminated – Mostly effective for mitigating metals mobility for the protection of groundwater, but not effective in reducing toxicity from the direct exposure to soils; not implementable for ubiquitous metals and heterogeneous soils; not effective for PAHs
		Chemical Oxidation	Conversion of inorganic contaminants to nonhazardous compounds using an oxidizing agent (EPA 1998a)	Eliminated – Not effective for metal COCs in soil; not efficient for low volumes of PAH soils at low concentrations
		Solvated Electron Process	Soil is treated by first mixing with liquid ammonia to form a soil/ammonia slurry, adding elemental calcium or sodium to the slurry; separating the ammonia from the soil as a liquid until most of the ammonia is removed and then as a vapor by warming the soil (Federal Remediation Technologies Roundtable 2005)	Eliminated – Not applicable for metals; highly exothermic reaction with health and safety concerns; not cost-effective for small volumes of PAHs; high cost
		Soil Vapor Extraction	VOCs are extracted from the unsaturated soil zone using vacuum pumps; also used with actively volatilization of VOCs in groundwater as it increases the amount of VOCs in the soil (EPA 1997b)	Eliminated – Not effective for metals or PAHs in soil

TABLE 4-1: SCREENING OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL (CONTINUED)

Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Screening Comments
Treatment	Thermal Treatment	Incineration	Volatilization and combustion of soil contaminants (Federal Remediation Technologies Roundtable 2005)	Eliminated – Not effective for metals; numerous regulatory requirements, low public acceptance; high cost
		Low Temperature Thermal Desorption	Volatilization of organic contaminants well below oxidation temperatures (Federal Remediation Technologies Roundtable 2005)	Eliminated – Not effective for metals; high cost
Containment	Covers	Soil Covers	Place a cover of "clean" soil over contaminated soil to eliminate the direct exposure pathway	Retained – Effective for metals and PAHs; easily and quickly implemented; moderate cost per area
		Asphalt or Concrete Covers	Place an asphalt or concrete cover over contaminated soil to eliminate the direct exposure pathway (EPA 1998b)	Retained – Effective for metals and PAHs; effective for ubiquitous metals; moderate cost per area
		Maintained Landscaping	Use maintained landscaping to prevent visible dust emissions resulting from wind erosion to eliminate direct exposure to wind-blown asbestos; use maintained landscaping over contaminated soil to eliminate the direct exposure pathway	Retained – Effective for asbestos and ubiquitous metals; moderate cost per area

Notes: Shaded process options are eliminated for further evaluation as a remedial alternative

bgs Below ground surface
COC Chemical of concern
EPA U.S. Environmental Protection Agency
NCP National Oil and Hazardous Substance Pollution Contingency Plan
PAH Polynuclear aromatic hydrocarbon
ROD Record of decision
VOC Volatile organic compound

<u>Sources</u>:

EPA. 1997a. "Best Management Practices (BMPs) for Soils Treatment Technologies." EPA 530-R-97-007. May.

EPA. 1997b. "Analysis of Selected Enhancements for Soil Vapor Extraction." EPA 542-R-97-007. September.

EPA. 1998a. "Field Applications of In Situ Remediation Technologies: Chemical Oxidation." EPA 542-R-98_008. September.

EPA. 1998b. "Evaluation of Subsurface Engineered Barriers at Waste Sites." EPA 542-R-98_005. August.

EPA. 2000a. The Office of Solid Waste and Emergency Response (OSWER) publication on Land Use Controls. Available Online at: http://www.epa.gov/oerrpage/superfund/action/ic/guide/index.htm

Federal Remediation Technologies Roundtable (FRTR). 2005. Federal Remediation Technologies Roundtable Website. Accessed on October 2005. Available Online at: http://www.frtr.gov

TABLE 4-2: SCREENING OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR GROUNDWATER
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Screening Comments
No Action	Not Applicable	Not Applicable	No Action	Retained – Required by NCP
Institutional Controls	Institutional Controls	Land Use Restrictions	Prohibits the extraction and use of groundwater at the site, except those actions performed in accordance with the site health and safety requirements; allow only designated land use in accordance with the proposed redevelopment plan (EPA 2000a)	Retained – Easily implemented and effective; usually required to restrict activity based on land use
		Covenants to Restrict Use of Property	Prohibits certain types of construction and development based on designated land use, and must be in accordance with the land use restrictions; includes criteria during and after development to ensure that mitigated exposure conditions to the groundwater and to VOCs from the vapor intrusion pathway are maintained or modified for continued protection for the receptors (EPA 2000a)	Retained – Easily implemented and effective; usually required to restrict activity based on land use
Access Restrictions	Engineering Controls	Barriers and Signs	Prohibits activities that could spread groundwater contamination by requiring locked well caps and secured utility access covers and requiring identification and securing any additional conduit where potential receptors could be exposed to the groundwater; requires posted signs and locked doors to prohibit occupancy of existing buildings or other enclosures where there is unacceptable risk from the vapor intrusion pathway (EPA 2000a)	Retained – Easily implemented and effective; prevents exposure to COCs
Monitoring	Monitoring	Monitoring	Groundwater is sampled and analyzed for COCs; results are evaluated and reported to assess changes in concentrations, and migration of the contaminants to potential exposure points (EPA 2004)	Retained - Easily implemented; effective for all COCs; low cost
Treatment	*Ex Situ* Pump and Treat	Chemical, physical, or biological treatment	Vertical or horizontal wells are pumped to extract contaminated groundwater from the saturated zone; extracted groundwater is treated through chemical, physical, or biological processes; treated water is released to the surface, to the surface water, or to a wastewater treatment plant (Federal Remediation Technologies Roundtable 2005)	Eliminated – Effective for all COCs, but not effective at low concentrations; may leave significant concentrations of COCs behind as the aquifer is dewatered; requires high level of effort to implement; high O&M cost; may have slow results

TABLE 4-2: SCREENING OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR GROUNDWATER (CONTINUED)
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Screening Comments
Treatment (Continued)	*Ex Situ* Pump and Treat	Dual-Phase Extraction	Vertical wells are pumped to extract contaminated groundwater, and are under negative pressure to extract volatile contaminants from the water surface, capillary fringe, and the vadose zone soils; Extracted groundwater and vapors are treated through chemical, physical, or biological processes (EPA 1999b)	Eliminated – Mostly effective for VOCs, but not effective for all COCs at low concentrations; not effective for metals; requires high level of effort to implement; high O&M cost; may have slow results
	In Situ Biological Treatment	Aerobic and Anaerobic Bioremediation	Electron donors, electron acceptors, nutrients, and possibly microorganisms, are injected into the contaminated groundwater, to create or enhance aqueous biological activity that degrades the contaminants to less toxic or mineralized compounds; Addition of sulfur-containing substrate can be added to treat chromium VI by complexation and sorbtion; Requires monitoring to assess remedial progress. (Federal Remediation Technologies Roundtable 2005)	Retained – Effective for VOCs at moderate to low concentrations; not necessarily effective for chromium VI unless additional chemical fixation substrate is included; easily implemented at moderate cost; no O&M cost; requires monitoring but treatment should reduce long-term monitoring effort
		Phytoremediation	Uses plant uptake to remove, transfer, stabilize, and destroy organic/inorganic chemicals in groundwater; requires monitoring to assess remedial progress (Ground-Water Remediation Technology Analysis Center 1997b)	Eliminated – Effective for VOCs at low concentrations, although not necessarily effective for chromium VI; may not be implementable with planned reuse; requires preliminary studies to determine appropriate species and assess remedial effectiveness; moderate implementation cost; moderate to low O&M cost; requires monitoring; may have slow results
	In Situ Physical/Chemical Treatment	Chemical Oxidation	Chemicals, such as hydrogen peroxide, potassium permanganate, or Fenton's reagent, are injected into the contaminated groundwater to enhance the oxidation state of the aquifer, chemically altering dissolved contaminants to less toxic compounds or precipitants; requires monitoring to assess remedial progress (EPA 1998a)	Retained – Moderately effective for VOCs at Parcel D but most efficient at high COC concentrations; implementable as a fast-reacting remedy; not known to be effective for chromium VI; moderate implementation costs with no O&M; requires monitoring but treatment should reduce long-term monitoring effort

TABLE 4-2: SCREENING OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR GROUNDWATER (CONTINUED)
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Screening Comments
Treatment (Continued)	*In Situ* Physical/Chemical Treatment (Continued)	Chemical Reduction	Chemicals, such as zero valent iron, are injected into the contaminated groundwater to enhance the reduction state of the aquifer; chemically altering dissolved contaminants to less toxic compounds or precipitants; requires monitoring to assess remedial progress (EPA 2000d)	Retained – Highly effective for VOCs and chromium VI but most efficient at high COC concentrations; implementable as a fast-reacting remedy; moderate success as pilot tests at HPS; moderate implementation costs with no O&M; requires monitoring but treatment should reduce long-term monitoring effort
		Electrokinetic Separation	Induced electronic current creates an acid front (low pH) at the anode and a base front (high pH) at the cathode; acidic conditions mobilize metal contaminants for transport and collection at the cathode; requires monitoring to assess remedial progress (Ground-Water Remediation Technology Analysis Center 1997a)	Eliminated – Highly effective for metals but less effective for VOCs; requires subsequent disposal of collected COCs that may need additional treatment before disposal; reactions may form undesirable byproducts; high setup and O&M cost
		Air Sparging with SVE	Air is injected into the aquifer to mobilize volatile COCs into the unsaturated vadose zone soil; VOCs are extracted from the soils with SVE system (Federal Remediation Technologies Roundtable 2005)	Eliminated – Highly effective for VOCs at moderate to high concentrations but not effective for chromium VI; SVE at HPS has had limited success due to heterogeneous soils; moderate level of effort to implement; implementation may conflict with planned reuse; high implementation and O&M cost, including disposal costs and/or surface treatment
		Ozone Sparging with SVE	Ozone is injected into the aquifer to mobilize volatile COCs into the unsaturated vadose zone soil and create a highly oxygenized environment; mobilized COCs are extracted from the soils with SVE system, and oxygenized groundwater chemically degrades COCs (EPA 1998a)	Eliminated – Moderately effective for VOCs at moderate to high concentrations but not effective for chromium VI or nickel; SVE at HPS has had limited success due to heterogeneous soils; implementation may conflict with planned reuse; high implementation and O&M cost, including disposal costs and/or surface treatment

TABLE 4-2: SCREENING OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR GROUNDWATER (CONTINUED)
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Screening Comments
Treatment (Continued)	*In Situ* Physical/Chemical Treatment (Continued)	Permeable Reactive Barriers	Passive or reactive treatment walls are installed across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall; these walls allow the water to pass while prohibiting movement of contaminants by employing agents such as zero-valent metals, chelators (ligands selected for their specificity for a metal), sorbents, microbes, and others; the contaminants will either be degraded or retained in a concentrated form by the barrier material; requires monitoring to assess remedial effectiveness (EPA 1998c)	Eliminated – High level of effort to implement; a passive treatment wall would treat only water that moves through the wall, but not the source area; may have slow results due to groundwater gradients at HPS; ineffective where preferential pathways exist; implementation may conflict with planned reuse; limited field data concerning the longevity of wall reactivity or loss or permeability due to precipitation (EPA 2000b); would not lessen the vapor intrusion pathway risk; high implementation and O&M cost
Removal	Pump and Dispose	Pumping	Large volumes of groundwater are pumped from the aquifer to capture the contaminated plume; the extracted groundwater is either released to a waste water disposal facility or is hauled off site for disposal (Federal Remediation Technologies Roundtable 2005)	Eliminated – Effective for all COCs; not effective in heterogeneous or tight lithologic conditions; may leave significant concentrations of COCs behind as the aquifer is dewatered; high level of effort to implement; high implementation and O&M cost; potentially high cost for disposal
Containment	Slurry Wall	Low-Permeability Wall	Install a low permeability material, such as bentonite, in a trench or through well injections around the perimeter of the COC plume to stops groundwater flow and prevent migration of contaminants; Requires monitoring to assess remedial effectiveness (EPA 1998b)	Eliminated – Low effectiveness in obtaining a complete seal; may cause hydrogeologic problems such as a groundwater "mound"; would not lessen the vapor intrusion pathway risk; high level of effort to implement, including permitting; implementation may conflict with planned reuse; high implementation and O&M cost

Notes:	Shaded process options are eliminated for further evaluation as a remedial alternative
COC	Chemical of concern
EPA	U.S. Environmental Protection Agency
HHRA	Human health risk assessment
HPS	Hunters Point Shipyard
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
O&M	Operations and maintenance
RAO	Remedial action objective
SVE	Soil vapor extraction
VOC	Volatile organic compound

<u>Sources</u>:

EPA. 1998a. "Field Applications of In Situ Remediation Technologies: Chemical Oxidation." EPA 542-R-98_008. September.

EPA. 1998b. "Evaluation of Subsurface Engineered Barriers at Waste Sites." EPA 542-R-98_005. August.

EPA. 1998c. "Permeable Reactive Barrier Technologies for Contaminant Remediation" EPA/600/R-98/125. September.

EPA. 1999b. "Multi-Phase Extraction: State-of-the-Practice." EPA 542-R-99/004. June.

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TABLE 4-3: ANALYSIS OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
				SOIL			
No Action	Not Applicable	Not Applicable	No Action	Does not achieve remedial action objectives	Not acceptable to local government or public	None	Retained, required by NCP
Institutional Controls	Institutional Controls	Land Use Restrictions	Prohibits activities not specified for the designated land use; prohibits growing produce in native soil	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination (EPA 2000a)	Requires legal documents and authority to enforce restrictions; easily implemented	Low cost	Retained; easily implemented and effective; usually required to restrict activity based on land use; low cost
		Covenants to Restrict Use of Property	Restricts the use of the parcel to those reuses that are identified at the time the ROD is signed; includes criteria during and after future development to assure that mitigated exposure conditions are maintained such as covers, barriers, or other engineering controls	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination (EPA 2000a)	Requires legal documents and authority to enforce restrictions; easily implemented	Low cost	Retained; easily implemented and effective; usually required to restrict activity based on land use; low cost
Access Restrictions	Engineering Controls	Barriers and Signs	Fencing, barriers, and posting signs to restrict land use where there is exposure to potentially contaminated soil	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination (EPA 2000a)	Requires legal documents and authority to enforce restrictions; easily implemented	Low cost	Retained; easily implemented and effective; usually required to restrict activity based on land use; low cost
Removal	Excavation	Conventional Excavation	Excavation of contaminants using conventional mechanical equipment	Effective at removing contamination and preventing long-term exposure to contamination; may expose workers and environment to contaminants during implementation; uses conventional construction methods; proven technology	Easily implemented for defined areas of contamination; easily implemented for lead and PAHs; not implementable for ubiquitous metals such as arsenic and manganese because of the large areas involved; may need to excavate entire redevelopment blocks to 10 feet.	Moderate cost (based on previous excavations at Parcel D, includes confirmation sampling requirements)	Retained for lead and PAHs; effective; easily implemented; fast; not retained for ubiquitous metals such as arsenic and manganese.
	Off-Site Disposal	Treatment/Disposal Facility	Transport and dispose of soils at a permitted treatment and disposal facility	Effective at preventing exposure of receptors to contamination; does not reduce total amount of contamination; may expose workers and environment to contaminants during implementation; conventional method	Requires appropriate transportation permits and waste characterization; easily implemented	High cost	Retained; effective; easily implemented; fast
Containment	Covers	Soil, Asphalt, or Concrete Cover	Place a soil, asphalt, or concrete cover over contaminated soil. Prevents contact with contamination (EPA 1998b).	Effective at preventing exposure of receptors to contamination, must be used with institutional controls to sustain protectiveness, susceptible to weathering and cracking	Paved areas can be easily maintained using conventional methods; soil or asphalt cover could be used in areas currently unpaved; easily implemented	Moderate cost	Retained for areas that are paved or require paving to achieve planned land uses; can be used with a soil cover
		Maintained Landscaping	Use maintained landscaping to prevent visible dust emissions resulting from wind erosion to eliminate direct exposure to wind-blown asbestos; use maintained landscaping over contaminated soil to eliminate the direct exposure pathway	Effective at preventing exposure of receptors to contamination, must be used with institutional controls to sustain protectiveness, susceptible to vegetative loss without proper maintenance.	Easy to construct; however, greater effort required for maintenance.	Low cost	Retained for unpaved areas

TABLE 4-3: ANALYSIS OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER (CONTINUED)
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
				GROUNDWATER			
No Action	Not Applicable	Not Applicable	No Action	Does not achieve remedial action objectives.	Not acceptable to local government or public	None	Retained; required by NCP.
Institutional Controls	Land Use Restrictions	Access Restrictions	Prohibits activities that could spread groundwater contamination, such as requiring locked well caps and secured utility access covers and requiring identification and securing of any additional conduit where potential receptors could be exposed to the groundwater; requires posted signs and locked doors to prohibit occupancy of existing buildings or other enclosures where there is unacceptable risk due to the vapor intrusion pathway	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination (EPA 2000a)	Requires legal documents and authority to enforce restrictions; easily implemented	Low cost	Retained; effective, easy to implement, and low cost
		Land Use Restrictions	Prohibits the extraction and use of groundwater at the site except in accordance with the health and safety requirements of the site; Allow only designated land use in accordance with the proposed redevelopment plan	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination (EPA 2000a)	Requires legal documents and authority to enforce restrictions; easily implemented	Low cost	Retained; effective, easy to implement, and low cost
		Covenants to Restrict Use of Property	Prohibits certain types of construction and development based on designated land use, and must be in accordance with the land use restrictions; Includes criteria during and after development to assure that mitigated exposure conditions to the groundwater and to VOCs from the vapor intrusion pathway are maintained or modified for continued protection for the receptors	Effective at preventing exposure of receptors to contamination, especially when used in combination with other options; does not reduce volume or toxicity of contamination (EPA 2000a)	Requires legal documents and authority to enforce restrictions; easily implemented	Low cost	Retained; effective, easy to implement, and low cost
Treatment	Passive	Monitoring	Groundwater is sampled and analyzed for constituents identified for detection monitoring and evaluation monitoring programs; typically 30 years although time frame can be reduced based on findings.	Does not achieve remedial action objectives; does not reduce the volume or toxicity of contamination; does not monitor attenuation parameters (EPA 2004)	Easily implemented	Low cost	Retained; while monitoring does not achieve remedial action objectives on its own, long-term monitoring may be an important component of the other alternatives
	In Situ Biological Treatment	Aerobic Bioremediation	Additives including electron donors, electron acceptors, nutrients, and microorganisms, if necessary, are introduced to groundwater in areas where contaminants are present to enhance biodegradation of BTEX compounds, chlorobenzene, and non-halogenated VOCs.	Aerobic bioremediation is effective at reducing BTEX compounds and chorinated benzenes (EPA 2000d); volume and toxicity of contamination is reduced; not shown to be effective for Chromium VI, PCE, and TCE	Easily implemented	Moderate cost	Retained as a possible polishing step following anaerobic bioremediation
		Anaerobic Bioremediation	Additives including electron donors, electron acceptors, nutrients, and sulphur-containing substrates (organosulfur compounds in a polylactate matrix,, lactate, molasses, vegetable oil, cheese whey), and microorganisms, if necessary, are introduced to groundwater in areas where chlorinated solvents are present to enhance biodegradation of chlorinated VOCs.	Treatability study at a Parcel C site at HPS indicates anaerobic bioremediation is effective at reducing chlorinated VOCs; Treatability study injected lactate and hydrogen into the aquifer (Shaw 2005); chromium VI reduction and immobilization demonstrated using organosulfate substrate (Willett and Kroenigsberg 2004); volume and toxicity of contamination is reduced. It would be possible to design a remedy using this technology to achieve a numerical remediation goal.	Easily implemented; substrates are nontoxic	Moderate cost (Willett and Kroenigsberg 2004; EPA 2000b; Shaw 2005)	Retained; results from treatability study at Parcel C demonstrate effectiveness at reducing chlorinated VOCs; relies on biodegradation; no adverse impact to San Francisco Bay if amendments follow preferential pathways

TABLE 4-3: ANALYSIS OF GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER (CONTINUED)
Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Screening Comments
				GROUNDWATER (Continued)			
Treatment (Continued)	*In Situ* Physical/Chemical Treatment	Chemical Oxidation	Chemicals (hydrogen peroxide, potassium permanganate, or Fenton's reagent) injected in the subsurface to enhance the oxidation of chlorinated VOCs and reduce chlorinated VOCs to nonhazardous or less toxic compounds that are more stable, less mobile, and inert (EPA 1998a).	Previous treatability study at Parcel C encountered preferential pathways and discharged to San Francisco Bay; effective at reducing the volume and toxicity of contamination; proven technology for VOCs; reactions (especially Fenton's reagent) can produce heat that may affect utilities or off-gas that may accumulate in buildings	Public acceptance may be difficult based on previous experience with chemical oxidation at Parcel C; moderately implementable	Moderate cost	Eliminated; potential for oxidant to follow preferential pathways, which may result in areas of incomplete treatment or migration; potential for off-gas to accumulate under buildings; higher cost than other alternatives
		Chemical Reduction	ZVI is injected into an aquifer, which encourages enhanced reductive dechlorination of chlorinated VOCs.	Treatability study of ZVI injection at Parcel C (Tetra Tech 2003b) resulted in a mass removal of about 57 percent, more than needed at Parcel D; radius of influence was approximately 10 feet or less based on ZVI study at Parcel B (ERRG and URS 2004); injected ZVI followed preferential pathways (utility lines) and daylighted at the surface due to tight soils despite hydrofracturing; proven technology. It would be possible to design a remedy using this technology to achieve a numerical remediation goal.	Implementable; regulatory agencies and public are familiar with the technology and the results of the pilot tests at Hunters Point Shipyard	Moderate to high cost; using same number of injection points as bioremediation; consumables cost is an order of magnitude more expensive than food sources in bioremediation; based on ZVI treatability studies at Parcels B and C	Retained; mass removal is more than needed at Parcel D; effective for chromium VI and for chlorinated VOCs (EPA 2000c)

Notes: Shaded process options are eliminated for further evaluation as a remedial alternative

BTEX Benzene, toluene, ethylbenzene, and xylenes
EPA U.S. Environmental Protection Agency
ERRG Engineering/Remediation Resources Group, Inc.
HPS Hunters Point Shipyard
IRTC Interstate Technology and Regulatory Cooperation
NCP National Oil and Hazardous Substances Pollution Contingency Plan
PAH Polynuclear aromatic hydrocarbon
PCE Tetrachloroethene
ROD Record of decision
TCE Trichloroethene
VOC Volatile organic compound
ZVI Zero-valent iron

<u>Sources</u>:

EPA. 1998a. "Field Applications of In Situ Remediation Technologies: Chemical Oxidation." EPA 542-R-98_008. September.
EPA. 1998b. "Evaluation of Subsurface Engineered Barriers at Waste Sites." EPA 542-R-98_005. August.
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EPA. 2000c. "Engineered Approaches to In Situ Bioremediation of Chlorinated Solvents: Fundamentals and Field Applications" EPA 542-R-00_008. July
EPA. 2000d. "In Situ Treatment of Soil and Groundwater Contaminated with Chromium" EPA/625/R-00/005. October.
EPA. 2004. "Demonstration of Two Long-Term Groundwater Monitoring Optimization Approaches." OSWER 5102G. EPA 542-R-04-001b. September.
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Tetra Tech EM Inc. 2003b. "Cost and Performance Report FEROX[sm] Injection Technology Demonstration, Parcel C, Remedial Unit C4, Hunters Point Shipyard, San Francisco, California" July 11.
Willett and Kroenigsberg. 2004. "Cost Effective Groundwater Remediation, Selected Battelle Conference Papers 2003—2004."

5.0 DEVELOPMENT AND DESCRIPTION OF REMEDIAL ALTERNATIVES

This section presents potential remedial alternatives developed for soil and groundwater at Parcel D based on the GRAs and process options evaluated in Section 4.0. The NCP states that the development and evaluation of remedial alternatives will reflect the scope and complexity of the remedial actions under consideration with regards to the environmental issues defined at the site. The number and types of alternatives to be analyzed will be determined for each site by taking into account the scope and characteristics of the environmental issues at Parcel D.

5.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Combinations of retained process options were developed into remedial alternatives that also satisfy the RAOs and meet the requirements of the ARARs. The remedial alternatives were derived using experience and engineering judgment to formulate process options into the most plausible site-specific remedial actions.

For soils remedial alternatives, the Navy's strategy is to remove the contaminated soils from the site by excavation and disposal wherever practical, and to remediate those soils that cannot be removed by preventing complete exposure pathways to the receptors. Based on the COCs identified in Section 3.0, and on their location and extent defined in Section 2.0, the lead- and PAH-contaminated soil can be removed, while the arsenic and manganese contamination will require remedial actions that prevent completion of exposure pathways. Various institutional controls are also integrated with each alternative to assure that the RAOs and ARARs are satisfied.

For groundwater remedial alternatives, the Navy's strategy is primarily to prevent complete exposure pathways to the receptors and to monitor the known impacted areas while the aquifer recovers. Various institutional controls are included in the groundwater remedial alternatives to assure that the RAOs and ARARs are satisfied. Two remedial alternatives that include *in situ* treatment are also considered. Only the A-aquifer is considered for these remedial alternatives because no COCs were identified in the B-aquifer.

Alternatives would become simpler under the recently stadium reuse plan at Parcel D. Fewer areas would be planned for excavation because of the change to the shallower 2-foot depth. An alternative that includes a cover would be similar under this reuse, but the type of cover would be determined in the RD stage. Groundwater alternatives would not be affected, except that the areas determined to require remediation would likely be smaller because of the recreational reuse.

Both soil and groundwater remedial alternatives include five-year reviews to confirm that the remedies are continuing to protect human health and the environment when residual concentrations of COCs are left in place. Costs for five-year reviews, as well as other long-term monitoring activities, are included in the cost estimates for all alternatives.

The alternatives developed for further analysis for both soil and groundwater are presented in the following sections.

5.1.1 Alternatives Developed for Soil

The alternatives developed for soil are summarized below.

Alternative S-1: No Action

For this alternative, no remedial action will be taken. Soil will be left in place without implementing any response actions. The no-action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives.

Alternative S-2: Institutional Controls and Maintained Landscaping

Alternative S-2 involves the use of institutional controls and maintained landscaping to meet all ARARs and RAOs. Institutional controls — including proprietary controls, restrictive covenants, restricted land uses, restricted activities, and prohibited activities — are described in Section 4.3 and will be implemented parcel-wide for all of the redevelopment blocks to prevent exposure to areas where potential unacceptable risk is posed by COCs in soil. Institutional controls would require preparation and approval of plans and specifications for all construction activities that may pose unacceptable exposure to construction workers. Plans and specifications would be required to evaluate and help reduce exposure risks posed by the soil COCs for all human receptors. Alternative S-2 would require fencing and signs to prevent access to contaminated soils. Land use controls also would prohibit construction of new or reuse of buildings over VOC plumes unless adequate measures are taken to prevent exposure of residents to VOCs in soil or groundwater, possibly through the use of vapor barriers or other vapor control systems. A LUC RD will be prepared to identify specific implementation actions to ensure compliance with the institutional controls and to specify roles and responsibilities for implementing, monitoring, and enforcing the institutional controls.

Maintained landscaping will be required for areas that are currently bare or where minimally vegetated soil would be disturbed by excavation or construction and not restored with a cover (for example, clean imported soil, asphalt, or concrete). Maintained landscaping would rely on seeding and maintaining a vegetative cover; no soil or asphalt would be added. The maintained landscaping would reduce exposure to asbestos that may be present in surface soil and that would not be addressed by institutional controls alone. Maintained landscaping will be accomplished for these areas by hydroseeding the areas with native, non-invasive plant species to restore the natural vegetation cover.

Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls

Alternative S-3 consists of soil excavation and off-site disposal, maintained landscaping, and institutional controls similar to those of Alternative S-2. In areas where lead and PAHs are COCs, soil above remediation goals will be excavated and disposed of at an off-site facility. This alternative will provide a more permanent remedy to reduce the volume and toxicity of contaminants where excavation is feasible. The total volume of excavation is 672 cubic yards and is discussed in more detail in Section 6.1.3. Figures 5-2, 5-3, and 5-4 show the excavations that are the basis for the cost estimate; detailed excavation plans will be developed in the RD. Appendix F provides more details on the costs associated with the excavation and disposal of soil at an off-site facility.

The institutional controls under this alternative would be used to prevent exposure to potential unacceptable risk posed by the COCs arsenic and manganese at concentrations above remediation goals that are left in soil. The institutional controls would be the same as Alternative S-2, would be implemented parcel-wide, and would be fully described in an LUC RD document. Areas of bare or minimally vegetated soil that have been disturbed by excavation or construction activities and not restored with a cover would require maintained landscaping as described in Alternative S-2.

Alternative S-4: Covers and Institutional Controls

Alternative S-4 consists of covers to ensure the exposure pathway to soil contaminants is incomplete and institutional controls similar to those in Alternatives S-2 and S-3. This alternative provides physical barriers to cut off the soil exposure pathways at Parcel D. Because of the ubiquitous nature of arsenic and manganese at concentrations exceeding remediation goals, covers would be installed and maintained across the entire parcel. In many locations, existing covers are considered adequate for this alternative. Where not present, a new cover would be constructed to infill areas that are not covered. Existing covers include buildings, roads, parking lots, and maintained landscaping. The need for upgrades or repairs to the existing covers would be assessed in the RD, and implemented for this alternative as necessary. The institutional controls are discussed in Section 4.3, would be implemented parcel-wide, and would be fully described in an LUC RD document.

Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls

Alternative S-5 consists of a combination of soil excavation and off-site disposal, covers, and institutional controls. This alternative was developed as a combined alternative to (1) remove and dispose of lead and PAHs as described in Alternative S-3, (2) implement and maintain block-wide covers as described in Alternative S-4, and (3) implement parcel-wide institutional controls as described in Alternative S-2.

5.1.2 Alternatives Developed for Groundwater

The following alternatives were developed for groundwater.

Alternative GW-1: No Action

For this alternative, no remedial action will be taken. Groundwater conditions will be left as is, without implementing any response actions. The no-action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives.

Alternative GW-2: Long-Term Groundwater Monitoring and Institutional Controls

Alternative GW-2 consists of long-term groundwater monitoring and institutional controls. This alternative monitors groundwater to ensure the ongoing protectiveness of institutional controls. Groundwater monitoring will confirm site conditions, and ensure that, over time, the potential exposure pathways remain incomplete. Groundwater monitoring would involve periodic groundwater sampling and analysis for all of the COCs and COECs identified in Section 4.1.2.1. The general objectives for groundwater monitoring for Alternative GW-2 include:

- Monitoring for the migration of COCs and COECs into previously uncontaminated areas and toward the Bay
- Monitoring to verify the results of the trigger level attenuation models
- Monitoring for changes in concentrations within plumes
- Monitoring concentrations in and near individual wells where the HHRA indicated potential risk

In summary, groundwater monitoring in this alternative primarily serves as a sentinel for conditions that could compromise the protectiveness of the remedy. Although not the goal of this alternative, natural processes may reduce contaminant concentrations over time.

Institutional controls are also included in this alternative. Institutional controls, discussed in Section 4.3, would be implemented parcel-wide, and would be fully described in a LUC RD document.

Alternatives GW-3A and GW-3B: *In Situ* Treatment for VOCs, Groundwater Monitoring for Metals and VOCs, and Institutional Controls

Alternatives GW-3A and GW-3B consist of *in situ* treatment of the VOC contaminant plumes. GW-3A and GW-3B do not treat metals in groundwater. These alternatives also include groundwater monitoring for metals and VOCs and institutional controls similar to those described for Alternative GW-2. Alternatives GW-3A and GW-3B involve using different *in* *situ* treatment reagents (a biological substrate for 3A and ZVI for 3B), to treat VOCs. The reagents are described in Section 5.3.3. Because Alternatives GW-3A and GW-3B do not treat metal COCs, metals would be monitored under this alternative. Alternatives GW-3A and GW-3B are intended to reduce the required time to meet the groundwater RAOs, and, as a result, the length of groundwater monitoring and possibly the time required for the institutional controls. The institutional controls in Alternatives GW-3A and GW-3B would be the same as the institutional controls in Alternative GW-2, would be implemented parcel-wide, and would be fully described in a LUC RD.

Alternatives GW-4A and GW-4B: *In Situ* Treatment for VOCs and Metals, Groundwater Monitoring, and Institutional Controls

Alternatives GW-4A and GW-4B consist of *in situ* treatment for both VOC and metal contaminants in groundwater. These alternatives also include groundwater monitoring and institutional controls. Alternatives GW-4A and GW-4B involve using biological and ZVI *in situ* treatment reagents for VOCs and metals as described in Alternatives GW-3A and GW-3B. These reagents are described in Sections 5.3.3 and 5.3.4. Alternatives GW-4A and GW-4B would take the most active approach toward reducing groundwater contaminant volume and toxicity, rather than treating only VOCs as proposed in Alternatives GW-3A and GW-3B. Alternatives GW-4A and GW-4B are intended to further reduce the time to meet the groundwater RAOs, the length of groundwater monitoring, and the time required for the institutional controls. The institutional controls in Alternatives GW-4A and GW-4B would be the same as the institutional controls in Alternative GW-2, would be implemented parcel wide, and would be more fully described in an LUC RD.

5.2 DESCRIPTION OF SOIL REMEDIAL ALTERNATIVES

Soil at Parcel D presents a potential unacceptable human health risk under the anticipated future land use scenario evaluated in the HHRA for this revised FS report (see Appendix B and Section 3.0). Five remedial alternatives were developed for soil: (1) a no-action alternative, (2) an institutional control alternative, (3) a removal action alternative with institutional controls, (4) a containment alternative with institutional controls, and (5) an alternative combining the removal action and containment, with institutional controls. All of these alternatives, excluding the no action alternative, are designed to address potential unacceptable risk associated with the planned reuse for each of the redevelopment blocks in the HHRA. These alternatives are described in the following sections, including notes on the major design assumptions that were used to estimate costs. Appendix F contains a more complete description of design assumptions and detailed alternative costs as they apply to each estimate.

5.2.1 Alternative S-1: No Action

Under Alternative S-1, no remedial action will be taken. Soil would be left in place as is, without implementing any institutional controls, containment, removal, treatment, or other mitigating actions. The no-action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives.

5.2.2 Alternative S-2: Institutional Controls and Maintained Landscaping

Alternative S-2 consists of institutional control and containment process options to prevent exposure to potential unacceptable risk posed by the soil. Institutional controls are described in detail in Section 4.3. Maintained landscaping will be required for areas that are currently bare or minimally vegetated soil that has been disturbed by excavation or construction activities and not restored with a cover (for example, clean imported soil, asphalt, or concrete). The maintained landscaping will serve to prevent exposure to asbestos that may be present in surface soil and transported by wind erosion, which would not be addressed by institutional controls alone.

5.2.3 Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls

Alternative S-3 consists of four retained process options: excavation of contaminated soil, off-site disposal of known and potentially contaminated soil, maintained landscaping, and institutional controls.

Soil would be excavated in specific areas within selected grids at Parcel D as described below:

1. Soil contaminated with lead and PAHs that present potential unacceptable incremental risk based on the planned reuse will be excavated. These excavations would occur in the following risk grids (see Figures 5-1 through 5-4):
   - Grid AT22 – Redevelopment Block 29;
   - Grid AV20 – Redevelopment Block DOS-1; and,
   - Grids BA22, BD29, BE26, BG31, BJ30, and BJ31 – Redevelopment Block DMI-1.
2. IR-09 is an area of concern because of chromium VI contamination. Between 1994 and 1996, the Navy conducted a removal action to reduce risk. However, the removal action was limited to aboveground structures and surficial residues. Plating vaults were emptied and covered, but soil under plating vaults was not investigated. Surface soil in this area was investigated in 1996, after the removal action. Some soil samples showed elevated levels of chromium-VI. IR-09 was further investigated during the RI and in the 2001 TCRA. Chromium VI was either not identified or remediated during these activities. However, these investigations did not focus on the area encompassing the vaults. This alternative includes further investigation of this area as a potential source for groundwater contamination. The decision to remediate this area will be made during the RD.

3. Soil will be excavated until results of confirmation samples indicate remediation goals for PAHs and lead are met or until the excavations extend to maximum depth of 10 feet bgs for industrial and educational/cultural redevelopment blocks, and to 2 feet bgs for open space redevelopment blocks. The open excavations will be backfilled with clean soil from an offsite source and the excavated soil containing COCs will be removed from the site and transported to an appropriate disposal facility. The proposed excavation areas are shown on Figures 5-2, 5-3, and 5-4. Based on these areas and depths, the combined volume of soil for all excavations is estimated to be 672 cubic yards of in place soil.

4. Existing soil piles at Parcel D that are suspected to contain COCs (see Figure 2-14) will also be removed from the site and transported to an appropriate disposal facility.

5. Areas of bare or minimally vegetated soil that have been disturbed by excavation or construction activities and not restored with a cover will be covered by maintained landscaping as described in Alternative S-2.

6. All other areas that present potential unacceptable risk from exposure to soil containing COCs other than lead and PAHs (see Figure 4-1) will be left in-place and addressed through the use of institutional controls.

Under this alternative, institutional controls would prevent exposure to potential unacceptable risk posed by the soil left in place. Institutional controls are described in detail in Section 4.3. As with Alternative S-2, the institutional controls, the institutional control objectives, and the specific institutional control implementation actions under this alternative would be more specifically described in an LUC RD document.

5.2.4 Alternative S-4: Covers and Institutional Controls

Alternative S-4 consists of two retained process options: soil covers and institutional controls. Under this alternative, the soils at Parcel D that present a potential unacceptable risk will be isolated by installing covers that cut off the potential exposure pathway. Institutional controls would prevent exposure to potential unacceptable risk posed by soil left in place.

Redevelopment blocks with soil containing metals (including lead), and PAHs that pose a potential unacceptable risk will be covered to allow for currently planned land uses. Covers will be applied to an entire parcel in consideration of the ubiquitous presence of arsenic and other metals present in the bedrock-derived fill material; the ease and efficiency of implementation, consistency in long-term enforcement, and effectiveness of long-term maintenance.

Covers will be achieved in two ways:

1. **Use of Existing Covers:** Existing asphaltic concrete and cementitious concrete (concrete) surfaces and buildings will be considered existing covers. These may include existing building footprints, roads, parking lots, and maintained landscaping. These existing covers may require rehabilitation such as sealing or repairing cracks to assure that the exposure pathway is incomplete.

2. **New Covers:** Where covers are needed, areas will be covered with a durable material that will not break, erode, or deteriorate such that the underlying soil becomes exposed. Standard construction practices for roads, sidewalks, and buildings would likely be adequate to meet this performance standard. Other examples of covers could include a minimum 4 inches of asphalt, a minimum 2 feet of clean imported soil, and maintained landscaping. All covers must achieve a full cover over the entire redevelopment block. The exact nature and specifications for covers can vary from block to block, but all covers must meet the performance standard of preventing exposure to soil and durability. Backfill soil will be tested and confirmed to be below remediation goals and to contain less than 0.25 percent asbestos. The soil cover may also overlay existing grades. Appropriate covers for the open space reuse blocks will depend on the details of redevelopment.

Institutional controls will be based on the intended reuse for each redevelopment block and designed to meet the RAOs and ARARs. Institutional controls are described in detail in Section 4.3.

5.2.5 Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls

Alternative S-5 consists of four retained process options: excavation of contaminated soil, off-site disposal of known and potentially contaminated soil, soil covers, and institutional controls. Alternative S-5 combines the excavation and soil cover actions to be more protective.

For Alternative S-5, soil would be excavated in those specific areas with lead and PAHs contamination within the selected grids described in Alternative S-3. Covers would be provided for several redevelopment blocks as described in Alternative S-4. As with Alternative S-2, this alternative contains institutional controls. Institutional controls will be based on the intended reuse for each redevelopment block and designed to meet the RAOs and ARARs applicable to the planned reuse. Institutional controls are described in detail in Section 4.3.

5.3 DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES

Groundwater in the A-aquifer presents a potential unacceptable risk by the indoor air inhalation pathway of VOCs as a result of vapor migration from the groundwater; therefore, VOCs were identified as COCs that require remedial action. In addition, a groundwater screening has identified two metals (chromium VI and nickel) as COCs that pose a potential risk to the Bay. Based on both the HHRA and the groundwater screening, there are no COCs identified for the B-aquifer at Parcel D.

Four remedial alternatives were developed for groundwater: (1) no action, (2) long-term groundwater monitoring and institutional controls, (3) *in situ* treatment for VOCs with reduced monitoring and institutional controls, and (4) *in situ* treatment for VOCs and metals with reduced monitoring and institutional controls. These alternatives are described in the following sections.

5.3.1 Alternative GW-1: No Action

Under Alternative GW-1, no remedial action will be taken. Groundwater would be left as is without implementing any institutional controls, containment, removal, treatment, or other mitigating actions. The no-action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives.

5.3.2 Alternative GW-2: Long-Term Groundwater Monitoring and Institutional Controls

Alternative GW-2 consists of groundwater monitoring. The groundwater monitoring described in this alternative includes monitoring for all of the COCs identified in Section 3.0, whether they were derived from the HHRA in Appendix B or were derived from the surface water criteria screening in Appendix H. It would also address the variations in physical parameters, such as the high pH observed historically at IR33MW61A.

Groundwater in the A-aquifer would be monitored where concentrations of metals and VOCs are detected. Groundwater in the A-aquifer at Parcel D is likely to be affected by the removal of sanitary sewer and storm drain lines that is scheduled as part of the basewide radiological removal program, to be completed in 2008. Consequently, groundwater will be monitored quarterly in the first 2 years following the approved ROD for this parcel, and then semi-annually for years 2 through 5. The cost estimates in Appendix F assume that all metals concentrations in groundwater will indicate clear trends similar to the present stable conditions that are below the trigger levels established in Appendix I for protection of the Bay; therefore, groundwater monitoring for metals would cease after year 5. Monitoring for VOCs is assumed to continue for a total of 30 years based on the present concentrations that have persisted above their risk-based acceptable levels. Although the CERCLA five-year review does not require monitoring, the monitoring schedule for VOCs is proposed for semi-annual monitoring (see Appendix E).

A general approach for groundwater monitoring for Alternative GW-2, and a detailed sampling design for each plume is presented in Appendix E. Results of groundwater monitoring will be used during five-year reviews to assess aquifer recovery, assess the monitoring program, adjust the data collection and analysis requirements, and evaluate the need for other response actions.

Institutional controls are part of Alternative GW-2 and are described in detail in Section 4.3. Institutional controls would be in place to prohibit occupancy of buildings or other enclosures where there is potential unacceptable risk from the vapor intrusion pathway and require engineering controls on all new buildings constructed in redevelopment blocks where groundwater plumes may present potential unacceptable risk from the vapor intrusion pathway.

5.3.3 Alternatives GW-3A and GW-3B: *In Situ* Treatment for VOCs with Reduced Groundwater Monitoring, and Institutional Controls

Alternatives GW-3A and GW-3B consists of three retained process options: (1) *in situ* treatment of groundwater for VOCs, (2) groundwater monitoring, and (3) institutional controls. The analysis of Alternatives GW-3A and GW-3B is based on *in situ* injection treatments. The only difference between Alternatives GW-3A and GW-3B are the types of material used to treat the groundwater. The groundwater treatment materials include a substrate for enhanced biodegradation (Alternative GW-3A), or a slurry of ZVI for chemical reduction (Alternative GW-3B). Specifically, these alternatives include:

1. *In situ* treatment using either the biodegradation substrate or ZVI, to actively mitigate VOC contaminants where concentrations are highest in each groundwater plume. This treatment is based on the groundwater plumes defined by the most recent groundwater data, presented in the nature and extent of groundwater contamination in Section 2.5. Further refinement of the details of *in situ* treatment options will occur during the RD. The RD will use updated information on plume extent and concentration to select the actual injection parameters. The assumed process involves a single injection of the treatment compound into the groundwater to reduce the contaminant concentrations to acceptable levels below their respective remediation goals. The treatment process also assumes that a successful injection can be implemented, as demonstrated during the pilot study at HPS Parcel B where 130,500 pounds of ZVI was injected in 2003.

   Relative low concentrations of VOCs in the groundwater at Parcel D are observed, compared to other remedial sites where injection treatments have been successful; therefore, using either biodegradation substrate or ZVI as the injection material has a high probability of success with one injection. However, there are differences in the way that these materials affect the VOCs.

   The biodegradation substrate treatment (Alternative GW-3A) is a glycerol polylactate, which causes reducing conditions in the aquifer by forming lactic acid and hydrogen. The microbes use the lactic acid and hydrogen to anaerobically degrade or mineralize the VOCs by breaking down the chemicals to their basic components through a process called reductive dechlorination. Glycerol polylactate treatment is a timed-release compound that will continue to react for up to several years, depending on the dose of the treatment. This timed-release reaction is beneficial in low-permeability aquifers such as the A-aquifer at Parcel D because the slow release allows more time for dispersion of the substrate and more time for the substrate to come in contact with, immobilize and mineralize the COCs.

   The ZVI treatment (Alternative GW-3B) involves the injection of a slurry of permeable carrier fluid with fine particles of ZVI. The ZVI reacts in groundwater to produce intermediate products, such as hydrogen, which dechlorinate and mineralize the VOCs. This reaction occurs quickly and readily and is effective for high concentrations of dissolved COCs and nonaqueous-phase liquids of COCs

(EPA 2000c). ZVI treatment is also effective for low concentrations of VOCs. The ZVI may also create a favorable environment for microbial dechlorination after the initial chemical reaction, depending on the dose of the ZVI and the conditions in the aquifer. As with Alternative GW-3A, this alternative assumes a single injection will be sufficient to treat groundwater to remediation goals.

2. Groundwater will be monitored for VOCs quarterly for Alternatives GW-3A and GW-3B for the first 2 years while the treatment is being implemented and is reacting with the groundwater contaminants. Because of the low concentrations of VOCs and the expected success of the treatments, one inoculation is anticipated to be successful. Three additional years of semi-annual monitoring is planned to assess potential rebound of the contaminants during seasonal fluctuations. Monitoring would cease following this period if goals and trigger levels are attained. Monitoring would also assess groundwater for concentrations of toxic degradation byproducts such as vinyl chloride. Should the degradation stall at vinyl chloride, injections for aerobic bioremediation could be employed. Because this is considered relatively unlikely given the low concentrations of VOCs at Parcel D, costs for this additional treatment are not included.

   Groundwater monitoring would also assess concentrations for the petroleum-related COCs benzene, naphthalene, and xylenes. These COCs were historically present at one well (IR33MW61A), and risks were evaluated as part of the groundwater assessment. Results from recent sampling events indicate that these COCs are no longer present at concentrations above remediation goals and are only found in an open space area where the vapor intrusion pathway is not complete. As a result, further treatment for benzene, naphthalene, and xylenes is not expected to be necessary. Aerobic bioremediation is an option in the unlikely event that the concentrations of these petroleum-related COCs rebound in areas where the vapor intrusion pathway may be complete based on planned reuse.

   Metals concentrations in groundwater will be monitored on the same schedule as described for Alternative GW-2. A general approach for groundwater monitoring for Alternatives GW-3A and GW-3B is presented in Appendix E.

3. The institutional controls described in Alternative GW-2 would be the same for this alternative.

5.3.4 Alternatives GW-4A and GW-4B: *In Situ* Treatment for VOCs and Metals with Reduced Groundwater Monitoring, and Institutional Controls

Alternatives GW-4A and GW-4B consists of the same three process options as Alternatives GW-3A and GW-3B: (1) *in situ* treatment of groundwater, (2) groundwater monitoring and (3) institutional controls. Compared with Alternatives GW-3A and GW-3B, Alternatives GW-4A and GW-4B add *in situ* treatment for metals.

In situ treatment for VOCs in Alternatives GW-4A and GW-4B will be the same as the *in situ* treatment for VOCs in Alternatives GW-3A and GW-3B, with the additional *in situ* treatment for metals. *In situ* treatment for metals (chromium VI and nickel) in Alternative GW-4A will use an organo-sulfur compound that causes anaerobic bioactivity to mitigate metal contaminants where concentrations are highest in each groundwater plume. Using the injected material, the microbes produce a metal-organo-sulfur complex that immobilizes the metals by strongly sorbing to the aquifer matrix. Dechlorination of VOCs under alternative GW-4A is achieved by the same treatment described under Alternative GW-3A. The ZVI chemical reduction in Alternative GW-4B also creates an anaerobic condition in the aquifer which enables biodegradation of the chromium VI and nickel plumes in much the same way that Alternative GW-4A mitigates these metal concentrations.

The treatment assessed in this alternative is based on the most recent groundwater data, presented in the nature and extent of groundwater contamination in Section 2.5. Further refinement of the details of *in situ* treatment options will occur during the RD. The RD will use updated information on plume extent, contaminant concentrations, and aquifer conditions to select the actual injection parameters. The assumed treatment process involves a single injection of the treatment compound into the groundwater to reduce the contaminant concentrations below their respective remediation goals. Like the biodegradation substrate treatment for VOCs, the metals treatment substrate is a timed-release compound that will continue to react for up to several years depending on the dose of the treatment. This timed-release reaction is beneficial in low-permeability aquifers like the A-aquifer at Parcel D because the slow release allows more time for dispersion of the substrate and more time for the substrate to come in contact with the COCs and cause them to be immobilized or mineralized. Similar to Alternatives GW-3A and GW-3B, Alternatives GW-4A and GW-4B assume that a single injection for metals treatment will be sufficient.

Groundwater will be monitored for VOCs and metals quarterly for Alternatives GW-4A and GW-4B for the first 2 years while the treatment is being implemented and is reacting with the groundwater contaminants. Because of the low concentrations of COCs and the expected success of the treatments, one inoculation is anticipated to be successful. Three additional years of semi-annual monitoring is planned to assess potential rebound of the contaminants during seasonal fluctuations. Monitoring would cease following this period if goals and trigger levels are attained. Similar to Alternatives GW-3A and GW-3B, groundwater monitoring would also assess concentrations of toxic degradation byproducts such as vinyl chloride, chromium III, and aerobic biodegradation would be employed, if necessary. Groundwater at well IR33MW61A would be monitored for residual petroleum contamination as described in Alternatives GW-3A and GW-3B. A general approach for groundwater monitoring for Alternatives GW-4A and GW-4B is presented in Appendix E.

FIGURES

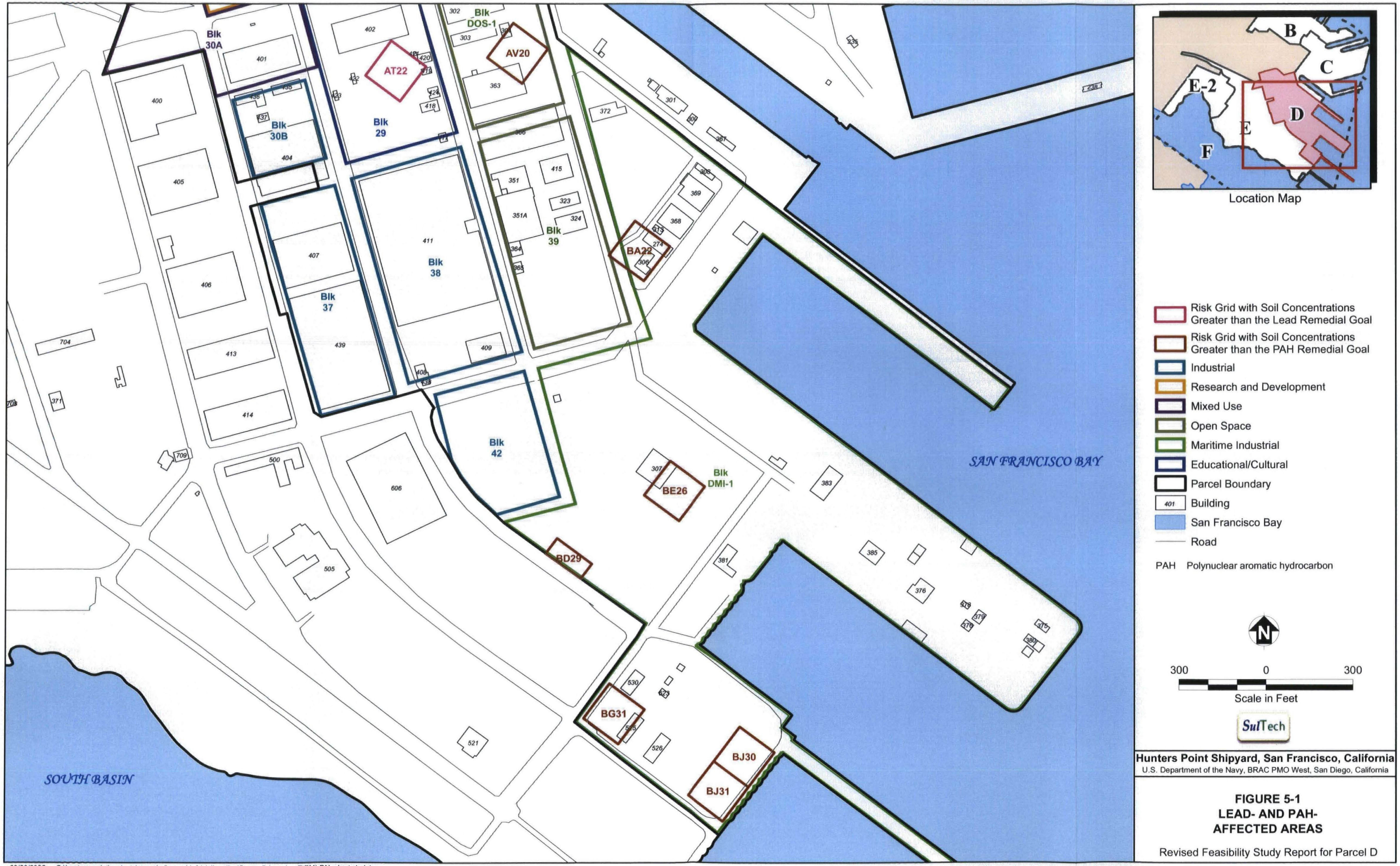

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FIGURE 5-1
LEAD- AND PAH-AFFECTED AREAS

Revised Feasibility Study Report for Parcel D

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Sample ID: 9013G167
Contaminant Driver: Lead
Detected Concentration(s): 920 mg/kg
Sample Depth: 1.25 ft
Sample ID: IR33B091
Contaminant Driver: Benzo(A)Pyrene
Detected Concentration(s): 0.49 mg/kg
Sample Depth: 2 feet
Sample ID: IR35SS15
Contaminant Driver: Benzo(A)Pyrene
Detected Concentration(s): 0.49 mg/kg
Sample Depth: 0.25 ft
Sample ID: IR35SS14
Contaminant Driver: Benzo(A)Pyrene
Detected Concentration(s): 1.00mg/kg
Contaminant Driver: Benzo(B)Fluoranthene
Detected Concentration(s): 2.20 mg/kg
Sample Depth: 0.25 ft
AT22
AV20
BA22
Blk 29
Blk DOS-1
Blk DMI-1
Blk 39
Blk 38
Parcel C
402
302
303
363
366
351
351A
364
365
411
407
439
415
324
372
301
300
308
369
368
313
306
417
418
419
420
421
422
423
424
Location Map
C
E-2
D
E
F
Soil Sample Locations with Lead and PAH Concentrations Less than Remedial Goals
Risk Grid with Soil Concentrations Greater than the Lead Remedial Goal
Risk Grid with Soil Concentrations Greater than the PAH Remedial Goal
Proposed Excavation
Sanitary Sewer Buffer (2.5 feet per side)
Building buffer (5 feet per side)
Industrial
Open Space
Research and Development
Maritime Industrial
Educational/Cultural
Parcel Boundary
411 Building
San Francisco Bay
Road
ft Feet
mg/kg Milligram per kilogram
PAH Polynuclear aromatic hydrocarbon
N
100 0 100
Scale in Feet
SulTech
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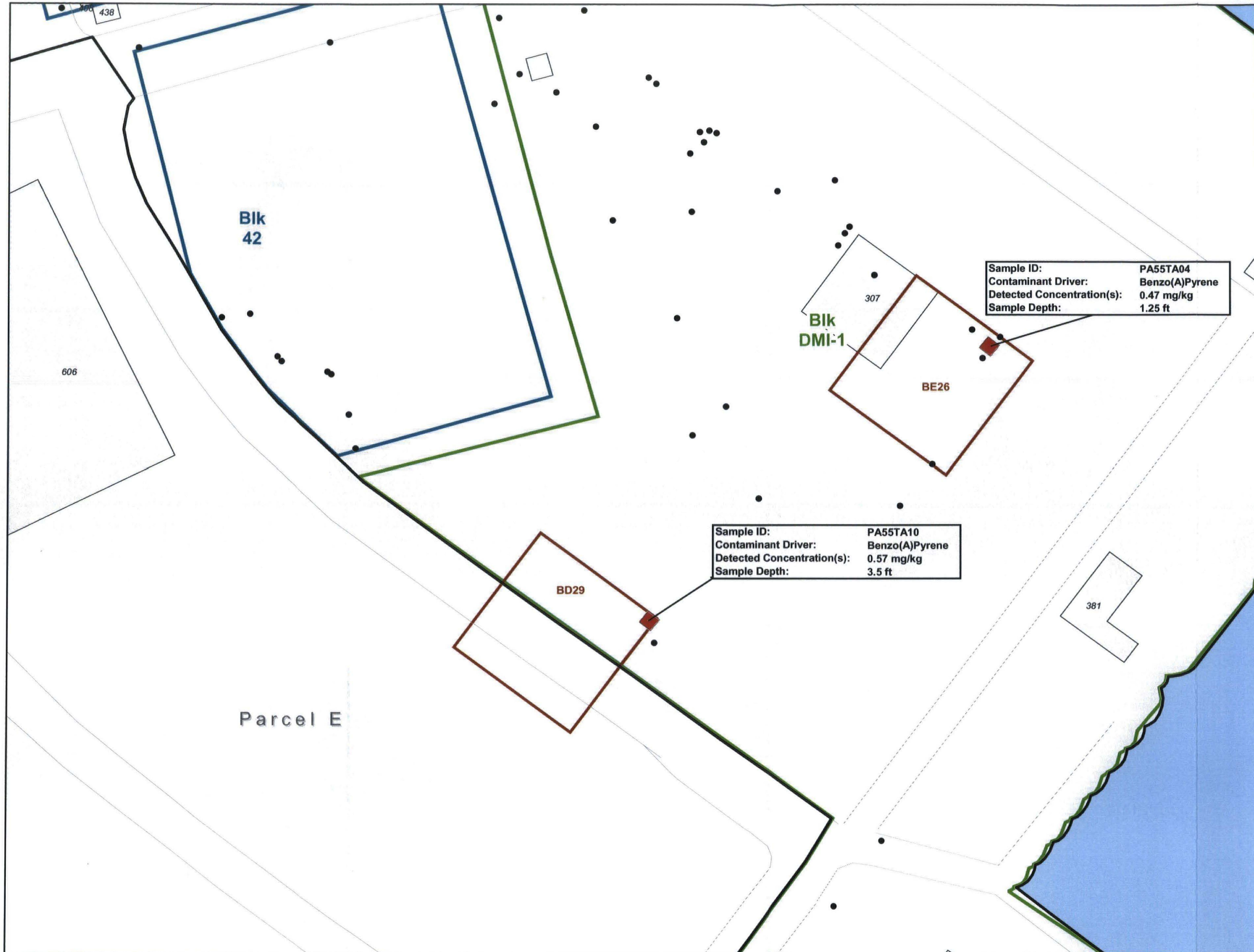
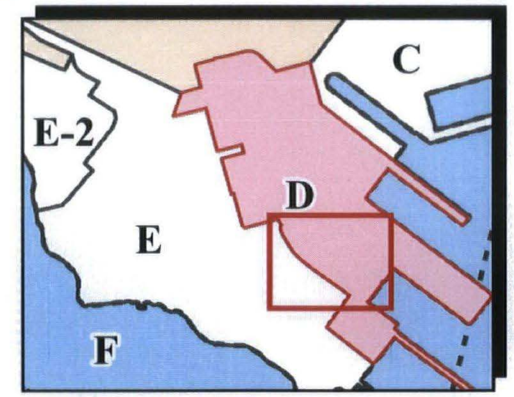
U.S. Department of the Navy, BRAC PMO West, San Diego, California
FIGURE 5-2
PROPOSED LEAD AND PAH EXCAVATIONS
Revised Feasibility Study Report for Parcel D





Location Map

- Soil Sample Locations with Lead and PAH Concentrations Less than Remedial Goals
- Risk Grid with Soil Concentrations Greater than the PAH Remedial Goal
- Proposed Excavation
- Industrial
- Maritime Industrial
- Parcel Boundary
- 381 Building
- San Francisco Bay
- Road

ft Feet
mg/kg Milligram per kilogram
PAH Polynuclear aromatic hydrocarbon

N

100 0 100
Scale in Feet

SulTech

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FIGURE 5-3
PROPOSED PAH EXCAVATIONS

Revised Feasibility Study Report for Parcel D

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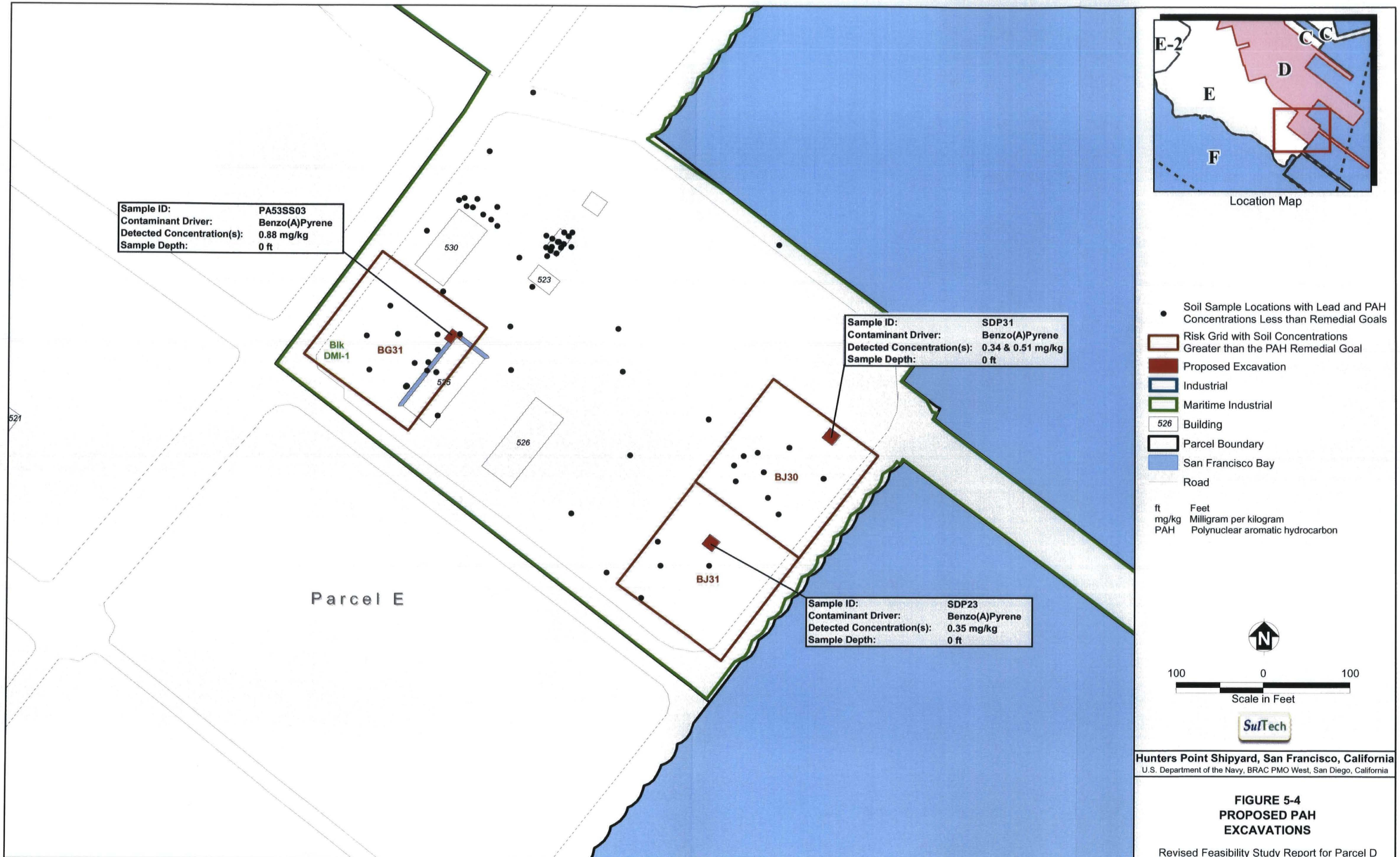

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FIGURE 5-4
PROPOSED PAH EXCAVATIONS

Revised Feasibility Study Report for Parcel D

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6.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section provides a detailed analysis of each remedial alternative developed in Section 5.0. This information will be used to help select a final remedy for Parcel D. The alternatives are evaluated using criteria based on statutory requirements of CERCLA as amended by Superfund Amendments and Reauthorization Act, Section 121; the NCP; and "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA 1988).

The NCP specifies nine criteria to be used in the comparative analysis. The first two criteria are threshold criteria that must be satisfied in order for a remedy to be eligible for selection; the next five criteria are balancing criteria used to evaluate the comparative advantages and disadvantages of the remedies; and the final two criteria are modifying criteria generally taken into account after agency and public comments are received on the FS and proposed plan. The nine criteria are summarized below.

Overall protection of human health and the environment: This criterion describes how each alternative, as a whole, protects human health and the environment and indicates how each hazardous substance source is to be eliminated, reduced, or controlled.

Compliance with ARARs: This criterion evaluates each alternative's compliance with ARARs, or, if an ARAR waiver is required, how the waiver is justified. ARARs consider location-specific, chemical-specific, and action-specific concerns.

Long-term effectiveness and permanence: This criterion evaluates the effectiveness of each alternative in protecting human health and the environment after the remedial action is complete. Factors considered include magnitude of residual risks and adequacy and reliability of release controls.

Reduction of toxicity, mobility, or volume through treatment: This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.

Short-term effectiveness: This criterion addresses the effectiveness of each alternative in protecting human health and the environment during the construction and implementation phase. Factors considered include:

- Protection of the community during remedial actions
- Protection of the workers during construction

- Environmental impacts
- Time required to achieve response objectives (achieve protection for the site or individual elements associated with specific risks)

Implementability: This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of the required services and materials during its implementation. Factors considered include:

- Ability to construct and operate the technology
- Availability and reliability of the technology
- Ease of undertaking additional remedial action
- Administrative implementability
- Coordination activities with other agencies
- Monitoring considerations
- Availability of equipment and specialists

Cost: This criterion evaluates the present value of the capitol and operation and maintenance (O&M) costs for each alternative. Capital and O&M cost estimates are order-of-magnitude-level estimates and have an expected accuracy of minus 30 to plus 50 percent (EPA 2000b). Table 6-1 summarizes the cost for each alternative.

Community Acceptance: This criterion evaluates issues and concerns the public may have regarding each alternative. This criterion will be assessed following receipt of community comments on the FS and the proposed plan.

Regulatory Agency Acceptance: This criterion evaluates technical and administrative issues and concerns the regulatory agencies may have about each alternative. This criterion will be assessed following receipt of agency comments on the FS and the proposed plan.

In the following sections, each remedial alternative is evaluated in comparison to the two threshold and five balancing NCP criteria, and subsequently compared to other alternatives to assess the relative performance with respect to these criteria. Comparison to the two modifying criteria of community and regulatory acceptance will be included in the proposed plan and ROD for Parcel D; further discussion of these criteria is not included in this revised FS report. Soil remedial alternatives are evaluated individually in Section 6.1 and compared with each other in Section 6.2. Groundwater remedial alternatives are evaluated individually in Section 6.3 and compared with each other in Section 6.4.

6.1 INDIVIDUAL ANALYSIS OF SOIL REMEDIAL ALTERNATIVES

This section evaluates each soil alternative in comparison to the two threshold and five balancing NCP evaluation criteria. Table 6-1 presents the cost summary for each alternative, and Table 6-2 provides a summary of each alternative's rating under the seven evaluation criteria. The ranking categories used in Table 6-2 and in the discussion of the alternatives are (1) protective or not protective, and meets ARARs or is not applicable, for the two threshold criteria; and (2) excellent, very good, good, marginal, and poor for the five balancing criteria.

6.1.1 Individual Analysis of Alternative S-1

Under Alternative S-1, no remedial action will be taken. Soil at Parcel D will be left in place as is, without implementing any institutional controls, containment, removal, treatment, or other response actions. The no action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives. Table 6-2 summarizes the analysis of Alternative S-1 relative to the evaluation criteria. The overall rating for this alternative is between marginal and good, although this alternative is not protective of human health and the environment and the ARARs are not applicable.

6.1.1.1 Overall Protection of Human Health and the Environment: Alternative S-1

At Parcel D, COCs pose unacceptable risks to human health under the proposed planned reuse for several redevelopment blocks. Alternative S-1 does not address these risks; therefore, Alternative S-1 is rated not protective for the overall protection of human health and the environment.

6.1.1.2 Compliance with ARARs: Alternative S-1

Because no action is proposed; therefore, the ARARs are not applicable.

6.1.1.3 Long-Term Effectiveness and Permanence: Alternative S-1

The factors evaluated under long-term effectiveness and permanence includes the magnitude of residual risks and the adequacy and reliability of the controls. Under the no action alternative, residual soils contamination above remediation goals have not been addressed. No controls to prevent exposure and no long-term management measures such as institutional controls are implemented. Based on this evaluation, the overall rating for Alternative S-1 for the long-term effectiveness and permanence is poor.

6.1.1.4 *Reduction of Mobility, Toxicity, or Volume through Treatment: Alternative S-1*

Alternative S-1 would not reduce the mobility, toxicity, and volume of hazardous substances at Parcel D because soil would not be treated, contained, or removed; therefore, the overall rating for Alternative S-1 for the reduction of mobility, toxicity, or volume through treatment is poor.

6.1.1.5 *Short-Term Effectiveness: Alternative S-1*

Four factors are considered when assessing the short-term effectiveness of an alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy and achieve protection. Each of these factors is assessed below for Alternative S-1.

No remedial actions would occur. The on-site community would not be exposed to additional risks from soil; the risks would be as presented in the risk assessment. The off-site community would be protected, as soils presenting unacceptable risk will not be disturbed.

No workers would be exposed to health risks during the Alternative S-1 implementation, because no remedial action will be taken. Risks to current workers at the site will remain as evaluated in the risk assessment.

No adverse environmental impacts would result from construction and implementation of Alternative S-1, because no remedial action will be taken.

Because no remedial action will be taken, there would be no time required to complete Alternative S-1.

The overall rating for Alternative S-1 for short-term effectiveness is very good based on no additional risks or exposure as compared to current conditions.

6.1.1.6 *Implementability: Alternative S-1*

Implementability includes technical and administrative feasibility and availability of required resources. No action would be required to implement this alternative; therefore, Alternative S-1 could be very easily implemented and the overall rating for Alternative S-1 for implementability is excellent.

6.1.1.7 *Cost: Alternative S-1*

No capital or O&M costs are associated with Alternative S-1; therefore, the overall rating for Alternative S-1 for cost is excellent.

6.1.1.8 *Overall Rating: Alternative S-1*

The overall rating for Alternative S-1 is between marginal and good. Although this alternative rates very good to excellent on some criteria, it is not protective of human health and the environment and the ARARs do not apply; therefore, this alternative is not a viable remedy for the environmental issues at Parcel D.

6.1.2 Individual Analysis of Alternative S-2

Alternative S-2 consists of the institutional controls generally described in Section 4.0. Table 6-2 summarizes the analysis of Alternative S-2 relative to the evaluation criteria. The overall rating for this alternative is between good and very good.

6.1.2.1 *Overall Protection of Human Health and the Environment: Alternative S-2*

Concentrations of COCs in soil above the remedial goals present a potential unacceptable human health risk based on the proposed land use scenario. Alternative S-2 provides protection to human health and the environment by limiting exposure to hazardous substances present in contaminated soil at Parcel D. Following development, institutional controls would prevent contact with the soil. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways outside of the planned reuse. Alternative S-2 is rated protective for the overall protection of human health and the environment.

6.1.2.2 *Compliance with ARARs: Alternative S-2*

Alternative S-2 consists of institutional controls as the only remedial action. As a result, chemical-specific ARARs are not applicable. This alternative would meet the action-specific ARARs. The location-specific ARARs identified for protection of the bridge crane, migratory birds, the coastal zone, and activities at Parcel D that affect the Bay also would be met because there is no remedial construction activity. Alternative S-2 would meet ARARs.

6.1.2.3 *Long-Term Effectiveness and Permanence: Alternative S-2*

The factors evaluated under long-term effectiveness and permanence includes the magnitude of residual risks and adequacy and reliability of controls. Under Alternative S-2, institutional controls prevent a complete exposure pathway to all potential human receptors. The adequacy and reliability of this alternative would be good in the short term, but depending on the maintenance of the ground controls and the degree of enforcement may be marginal in the long term. An LUC RD would be prepared to guide implementation of institutional controls. The overall rating for Alternative S-2 for the long-term effectiveness and permanence is marginal.

6.1.2.4 *Reduction of Mobility, Toxicity, or Volume through Treatment: Alternative S-2*

Alternative S-2 would not reduce the mobility, toxicity, or volume of hazardous substances through treatment at Parcel D because the soil would not be treated. However, the soil pathway would be broken as a condition of the institutional controls and the implementation of engineering controls. Where there are existing covers, the institutional controls include maintaining these covers. Where there is uncovered soil, the pathway would be broken by restricting access with engineering controls such as fences, signs, and landscape maintenance. For ease of implementing this maintenance, the institutional control would be applied across the entire parcel. Because the institutional controls include maintaining the fences and signs as well as maintaining the landscape, the exposure to COCs that present a potential unacceptable risk would be eliminated. Because the pathways are broken across the entire parcel, this remedy eliminates exposure to the chemicals identified in soil in both the incremental and the total risk assessments. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways external to the planned reuse. Although this alternative is effective in eliminating the exposure by breaking the pathway, it does so without treatment; therefore, the overall rating for Alternative S-2 for the reduction of mobility, toxicity, or volume through treatment is poor.

6.1.2.5 *Short-Term Effectiveness: Alternative S-2*

Four factors are considered when assessing the short-term effectiveness of an alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy. Each of these factors is assessed below for Alternative S-2.

The on-site and off-site community would be protected because soils presenting an acceptable risk would not be significantly disturbed during implementation of institutional controls.

Barriers, fences, signs, and covering landscape would be constructed and maintained for Alternative S-2. Minimal exposure to workers would occur during construction. Some existing fences and available landscape covers would be used. However, most of these activities would be around the perimeter of the areas of exposed soil, and health and safety requirements and personal protective equipment protocols would be enforced to minimize the exposure risk.

Construction efforts for Alternative S-2 are minimal. Parcel D does not contain terrestrial habitat. Storm water best management practices under the basewide storm water plan would prevent soil from reaching the Bay during construction of fences and implementation of covers under institutional controls.

The estimated time required to implement Alternative S-2 is approximately 6 months, and the effects of implementing this alternative would be nearly immediate.

The overall rating for Alternative S-2 for the short-term effectiveness is very good.

6.1.2.6 Implementability: Alternative S-2

Implementability includes technical and administrative feasibility and availability of required resources. Minimal construction and maintenance operations would be required to implement Alternative S-2; therefore, the alternative would be technically feasible and easily implemented. In addition, the administrative covenants to restrict use of property associated with this alternative would be straightforward to implement; however, continuous inspections and five-year reviews and reporting make the long-term implementability difficult. The overall rating for Alternative S-2 for implementability is good.

6.1.2.7 Cost: Alternative S-2

The total capital and O&M costs for Alternative S-2 are presented in Table 6-1 and detailed in Appendix F. The overall rating for Alternative S-2 for cost is excellent; costs are less than half the next least expensive alternative (excluding no action), and less than 15 percent of the most expensive alternative.

6.1.2.8 Overall Rating: Alternative S-2

The overall rating for Alternative S-2 is between good and very good. Threshold criteria are met, and the institutional controls require prevention of exposure pathways for all COCs.

6.1.3 Individual Analysis of Alternative S-3

As discussed in Section 5.2.3, Alternative S-3 consists of (1) excavation and off-site disposal of lead- and PAH-contaminated soil, and (2) the institutional controls, generally described in Section 4.0, and engineering controls. Table 6-2 summarizes the analysis of Alternative S-3 relative to the evaluation criteria. The overall rating for Alternative S-3 is between good to very good.

6.1.3.1 Overall Protection of Human Health and the Environment: Alternative S-3

Alternative S-3 would protect human health and the environment because it removes soil contaminated with lead and PAHs that present potential unacceptable risk for the planned reuse. All other areas with potential unacceptable risk based on planned reuse would be mitigated by implementing institutional controls. Areas where soil would be removed would have an excellent overall protection rating, while the areas addressed by institutional controls only would have a very good rating. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways outside of the planned reuse. Therefore, Alternative S-3 is rated protective for the overall protection of human health and the environment criterion.

6.1.3.2 Compliance with ARARs: Alternative S-3

Alternative S-3 includes both institutional controls and remedial actions. Both action- and chemical-specific ARARs associated with this alternative would be met. The location-specific ARARs identified for protection of the bridge crane, migratory birds, the coastal zone, and activities at Parcel D that affect the Bay would also be met. Proposed covers are adequate to block exposure to ubiquitous arsenic and other metals in the bedrock-derived fill.

6.1.3.3 Long-Term Effectiveness and Permanence: Alternative S-3

The factors evaluated under long-term effectiveness and permanence includes the magnitude of residual risks and adequacy and reliability of controls. Under Alternative S-3, contaminated soil in excavated areas would be removed and disposed of off site. Excavation would continue until results of confirmation samples indicate remediation goals for PAHs and lead are met or until excavation would extend to a depth of 10 feet bgs, in residential and industrial reuse areas, and 2 feet bgs, in recreational areas. Areas with arsenic and manganese concentrations above remediation goals would be addressed through implementation of institutional controls. Long-term effectiveness and permanence in areas where lead and PAHs would be excavated is rated as excellent. In areas where only institutional controls are used, the adequacy and reliability of this alternative are very good. The overall rating for Alternative S-2 for long-term effectiveness and permanence is good.

6.1.3.4 Reduction of Mobility, Toxicity, or Volume through Treatment: Alternative S-3

Alternative S-3 would not reduce the mobility, toxicity, or volume of hazardous substances through treatment at Parcel D because the soil would not be treated. However, the volume of on-site PAHs and lead would be reduced by excavating and disposing soil with concentrations above remediation goals to a treatment and disposal facility. Also, the soil exposure pathway for COCs that pose an unacceptable risk would be broken as a condition of the institutional controls and the implementation of engineering controls. As with Alternative S-2, where there are existing covers, the institutional controls include maintaining these covers. Where there is uncovered soil, the pathway would be broken by restricting access with engineering controls such as fences and signs. For ease of implementation, the institutional control would be applied across the entire parcel. Because the institutional controls include maintaining the fences and signs as well as maintaining the covers, the exposure to COCs that present a potential unacceptable risk at Parcel D would be eliminated. Because the pathways are broken across the entire parcel, this remedy eliminates exposure to the chemicals identified in soil in both the incremental and the total risk assessments. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways external to the planned reuse. Although this alternative is effective in eliminating the exposure by removing some volume of PAH and lead contaminated soil from the site, and by breaking the soil exposure pathway, it does so without treatment. Therefore, the overall rating for Alternative S-3 for the reduction of mobility, toxicity, or volume through treatment is poor.

6.1.3.5 Short-Term Effectiveness: Alternative S-3

Four factors are considered when assessing the short-term effectiveness of an alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to complete remedial action. Each of these factors is assessed below for Alternative S-3.

The community would be protected by implementing containment controls such as dust suppression during the excavation, and covers over the hauling trucks during off-site transportation. The total volume of excavation is 672 cubic yards, or approximately 48 truck loads (14 cubic yards per truck). This volume represents a very limited risk to the community, particularly in comparison to ongoing work on other parcels.

Workers would be protected during soil excavation by implementing containment controls, such as dust suppression during excavation, stockpiling and loading trucks, and following health and safety protocols, including personal protective equipment and decontamination procedures. As with Alternative S-2, the institutional controls would require installing barriers, fences, and signs, and health and safety requirements and personal protective equipment protocols would be enforced to minimize the worker exposure during these activities.

Construction efforts for the soil removal involve only a few areas to be excavated and a relatively small volume of soil; therefore, the adverse environmental impacts from implementing the removal and disposal activities would be small. The construction efforts for implementing the institutional controls for Alternative S-3 are nearly the same as for Alternative S-2. Best management practices for construction will ensure that effects would be minimal.

The estimated time required to implement Alternative S-3 is less than 1 year, and the effects of implementing this alternative are nearly immediate.

The overall rating for Alternative S-3 for the short-term effectiveness is very good.

6.1.3.6 Implementability: Alternative S-3

Implementability includes technical and administrative feasibility and availability of required resources. The alternative is technically feasible and easily implemented because excavation and hauling are considered conventional and commonplace technologies. In addition, the institutional controls proposed for this alternative are easy to implement administratively. The overall rating for Alternative S-3 for implementability is very good.

6.1.3.7 Cost: Alternative S-3

The total capital and O&M costs and parameters used to derive present worth costs for Alternative S-3 are presented in Table 6-1 and detailed in Appendix F. The overall rating for Alternative S-3 for cost is very good.

6.1.3.8 Overall Rating: Alternative S-3

The overall rating for Alternative S-3 is between good and very good. Long-term exposure to PAHs and lead is reduced through excavation and off-site disposal, and institutional controls prevent exposure to all remaining COCs.

6.1.4 Individual Analysis of Alternative S-4

Alternative S-4 includes (1) covers over entire blocks where there is an unacceptable incremental risk and (2) the institutional controls generally described in Section 4.0. The covers will mitigate the potential risks by preventing a complete exposure pathway. Because the pathways are broken across the entire redevelopment block, this remedy eliminates exposure to the chemicals identified in soil in both the incremental and the total risk assessments. Table 6-2 summarizes the analysis of Alternative S-4 relative to the evaluation criteria. The overall rating for Alternative S-4 is between good and very good.

6.1.4.1 Overall Protection of Human Health and the Environment: Alternative S-4

Alternative S-4 provides protection to human health and the environment because soils that cause potential unacceptable risk based on planned future land use would be covered. These covers would be implemented over the entire redevelopment block. The proposed covers are adequate to block exposure to ubiquitous arsenic and other metals in the bedrock-derived fill. This alternative is also protective of human health and the environment through the use of institutional controls that restrict the reuse of the redevelopment blocks to those activities that would not present a potential unacceptable risk and require the maintenance of the covers. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways outside of the planned reuse. Alternative S-4 is rated protective for the overall protection of human health and the environment criterion.

6.1.4.2 Compliance with ARARs: Alternative S-4

Alternative S-4 consists of containment mitigation using covers and institutional controls. Action-specific and chemical-specific ARARs associated with this alternative would be met. The location-specific ARARs identified for protection of the bridge crane, migratory birds, the coastal zone, and activities at Parcel D that affect the Bay would also be met. Alternative S-4 meets ARARs.

6.1.4.3 Long-Term Effectiveness and Permanence: Alternative S-4

The factors evaluated under long-term effectiveness and permanence includes the magnitude of residual risks and adequacy and reliability of controls. Under Alternative S-4, risks associated with exposure to COCs in soil are mitigated by covering the soils. As a result, the exposure pathways are cut off. The adequacy and reliability of the institutional controls depend on monitoring and maintenance of the covers. The overall rating for Alternative S-4 for the long-term effectiveness and permanence is very good.

6.1.4.4 Reduction of Mobility, Toxicity, or Volume through Treatment: Alternative S-4

Alternative S-4 would not reduce the mobility, toxicity, or volume of hazardous substances through treatment at Parcel D because the soil would not be treated. However, the soil pathway would be broken as a condition of the institutional controls and the implementation of cover over soil exposure areas. Where there are existing covers, the institutional controls include maintaining these covers. Where there is uncovered soil, the pathway would be broken by installing new covers for all exposed soil areas within Parcel D where a potential unacceptable risk has been identified according to the planned reuse. For ease of implementation, the covers, and the institutional controls to maintain these covers, would be applied across the entire parcel. Because the soil exposure pathways are broken across the entire parcel, this remedy eliminates potential hazardous exposure to the chemicals identified in soil in both the incremental and the total risk assessments. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways external to the planned reuse. Although this alternative is affective in eliminating the exposure by breaking the pathway, it does so without treatment; therefore, the overall rating for Alternative S-4 for the reduction of mobility, toxicity, or volume through treatment is poor.

6.1.4.5 Short-Term Effectiveness: Alternative S-4

Four factors are considered when assessing the short-term effectiveness of an alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy. Alternative S-4 involves construction activity but not excavation and transportation of hazardous substances. Each of these factors is assessed below for Alternative S-4.

Risks to the community and current occupants may occur due to increased construction traffic. Only soil, which has been analyzed for possible contamination to demonstrate that the soil does not contain concentrations greater than the remedial goals, or typical construction asphalt, would be imported to construct the covers. The trucks hauling this material would cover their loads and adhere to a traffic plan that mitigates noise and traffic concerns of the community. Most of Parcel D is already covered with buildings, asphalt, or concrete, and repairs to these covers would cause minimal disturbance and impact to the community.

Risk to workers that are constructing covers over known contaminated soil may occur. However, workers would adhere to a chemical- and activity-specific health and safety plan, which would include the assignment of appropriate personal protective equipment and protective exposure measures.

Environmental impacts would be mitigated with effective work practices. Parcel D does not contain terrestrial habitat. Best management practices for construction will prevent soil from reaching the Bay during construction.

There would be a little impact from the time required to complete the remedial action because the activities would likely be completed in 6 months or less.

The overall rating for Alternative S-4 for short-term effectiveness, including implementing the institutional controls, is very good.

6.1.4.6 Implementability: Alternative S-4

Implementability includes technical and administrative feasibility and availability of required resources. The alternative is technically feasible and easily implemented because grading and installing covers, and repairing and monitoring existing concrete and asphalt covers are conventional and commonplace technologies. Fences and signs are not required for Alternative S-4, improving the ease of movement and use of Parcel D prior to development. In addition, the institutional controls are administratively easy to implement. The overall rating for Alternative S-4 for implementability is very good.

6.1.4.7 Cost: Alternative S-4

The total capital and O&M costs for Alternative S-4 are presented in Table 6-1 and detailed in Appendix F. The overall rating for Alternative S-4 for cost is good.

6.1.4.8 Overall Rating: Alternative S-4

The overall rating for Alternative S-4 is between good and very good. Exposure and mobility are reduced through the use of soil covers for all redevelopment blocks within Parcel D, and institutional controls maintain the covers and prevent exposure to all COCs.

6.1.5 Individual Analysis of Alternative S-5

Alternative S-5 combines excavation and off-site disposal (Alternative S-3) and soil covers (Alternatives S-4) to remediate those redevelopment blocks where a potential unacceptable risk occurs due to contaminated soils based on planned land use. By using both removal and containment approaches, the overall protectiveness of the alternative is increased. Alternative S-5 will involve the removal of soils with lead and PAHs that pose a potential unacceptable risk, and covers over other soil areas that are known to contain COCs that cause a potential unacceptable risk. Alternative S-5 also includes the institutional controls described in Section 4.0. Table 6-2 summarizes the analysis of Alternative S-5 relative to the evaluation criteria. The overall rating for Alternative S-5 is between very good and excellent.

6.1.5.1 Overall Protection of Human Health and the Environment: Alternative S-5

Alternative S-5 would protect human health and the environment because soil contaminated with lead and PAHs causing potential unacceptable risk would be removed and all other soils within those redevelopment blocks where potential unacceptable risk has been identified will be covered. The proposed covers are adequate to block exposure to ubiquitous arsenic and other metals in the bedrock-derived fill. Institutional controls for this alternative would also be protective of human health and the environment because they will ensure covers are maintained parcel-wide. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways outside of the planned reuse. Alternative S-5 is rated protective for the overall protection of human health and the environment criterion.

6.1.5.2 Compliance with ARARs: Alternative S-5

Alternative S-5 consists of removal, containment, and institutional controls. As a result, action-specific and chemical-specific ARARs are associated with this alternative and would be met. The location-specific ARARs identified for protection of the bridge crane, migratory birds, the coastal zone, and activities at Parcel D that affect the Bay would also be met. Alternative S-5 meets ARARs.

6.1.5.3 Long-Term Effectiveness and Permanence: Alternative S-5

The factors evaluated under long-term effectiveness and permanence includes the magnitude of residual risks and adequacy and reliability of controls. Under Alternative S-5, soils with lead and PAHs presenting a potential unacceptable risk would be removed. In addition, residual risks from other COCs would be mitigated through the use of covers or access restrictions that prevent the exposure pathways. The adequacy and reliability of the institutional controls depend on monitoring and maintenance of the covers and other land use and covenants to restrict use of property to continue their effectiveness. The overall rating for Alternative S-5 for long-term effectiveness and permanence is excellent.

6.1.5.4 Reduction of Mobility, Toxicity, or Volume through Treatment: Alternative S-5

Alternative S-5 would not reduce the mobility, toxicity, or volume of hazardous substances through treatment at Parcel D because the soil would not be treated. However, the volume of on-site PAHs and lead would be reduced by excavating and disposing soil with concentrations above remediation goals to a treatment and disposal facility as the same remedy in Alternative S-3. Also, the soil exposure pathway would be broken where soils are not excavated as a condition of the institutional controls and the implementation of cover over soil exposure areas. Where there are existing covers, the institutional controls include maintaining these covers. Where there is uncovered soil, the pathway would be broken by installing new covers for all exposed soil areas within Parcel D where a potential unacceptable risk has been identified according to the planned reuse. For ease of implementation, the covers, and the institutional controls to maintain these covers, would be applied across the entire parcel. Because the soil exposure pathways are broken across the entire parcel, this remedy eliminates potential hazardous exposure to the chemicals identified in soil in both the incremental and the total risk assessments. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways external to the planned reuse. Although this alternative is effective in eliminating the exposure by removing some volume of PAH and lead contaminated soil from the site, and by breaking the soil exposure pathway through the use of covers, it does so without treatment. Therefore, the overall rating for Alternative S-3 for the reduction of mobility, toxicity, or volume through treatment is poor.

6.1.5.5 Short-Term Effectiveness: Alternative S-5

Four factors are considered when assessing the short-term effectiveness of an alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy. Each of these factors is assessed below for Alternative S-5.

Risks to the community and current occupants may occur by excavating and transporting contaminated soils off site; however, these risks would be minimized by implementing containment controls, such as dust suppression during excavation, and covers over the hauling trucks during off-site transportation. Alternative S-5 would also pose added risks to the community and current occupants by increased construction traffic. Clean soil or asphalt would be imported to backfill the excavations and construct the covers; however, the hauling trucks would cover their loads and adhere to a traffic plan that mitigates noise and traffic concerns of the community.

Risks to workers that are excavating and hauling soil and constructing covers over known contaminated soil will require mitigation. All of the workers would adhere to a chemical- and activity-specific health and safety plan, which would include the assignment of appropriate personal protective equipment, decontamination procedures, and protective exposure measures.

Adverse environmental impacts from implementing the removal and disposal activities may occur due to disrupting soil and causing fugitive dust. However, soil removals would involve only a few areas and a relatively small volume of soil. Most of Parcel D is industrial and already contains existing covers, resulting in no existing terrestrial habitat within Parcel D; therefore, the adverse environmental impacts from implementing the covers will be low.

The time required to complete the remedial action is less than 1 year.

The overall rating for Alternative S-5 for the short-term effectiveness, including implementing the institutional controls is excellent.

6.1.5.6 Implementability: Alternative S-5

Implementability includes technical and administrative feasibility and availability of required resources. Alternative S-5 would be technically feasible and easily implemented because excavating, hauling, backfilling, grading, installing covers, and repairing existing concrete and asphalt covers are conventional and commonplace technologies. In addition, the institutional controls are easy to administratively implement. The overall rating for Alternative S-5 for implementability is very good.

6.1.5.7 Cost: Alternative S-5

The total capital and O&M costs for Alternative S-5 are presented in Table 6-1 and detailed in Appendix F. Alternative S-5 is the most expensive alternative. The overall rating for Alternative S-5 for costs is good.

6.1.5.8 Overall Rating: Alternative S-5

The overall rating for Alternative S-5 is between very good and excellent. Exposure to COCs and all chemicals present in soil is prevented with soil covers or access restrictions. PAHs and lead are removed by excavation and disposal. Long-term protectiveness is provided with institutional controls.

6.2 COMPARISON OF SOIL REMEDIAL ALTERNATIVES

This section compares the five soil alternatives. The discussion of each evaluation criterion generally proceeds from the alternative that best satisfies the criterion to the one that least satisfies the criterion. Table 6-2 summarizes the rating for each alternative and shows a comparison of each alternative's ratings for the two threshold and five balancing NCP evaluation criteria.

6.2.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is a threshold criterion. Protection is not measured by degree; rather, each alternative is considered as either protective or not protective. Alternatives S-2 through S-5 are protective of human health and the environment under the anticipated future land use of the site. Alternative 1 does not mitigate the risks at the site and hence does not provide adequate protection to human health and the environment.

6.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Compliance with ARARs is a threshold evaluation criterion. An alternative must either comply with ARARs or provide grounds for a waiver. Alternatives S-2 through S-5 comply with all pertinent ARARs. For the no action alternative, Alternative 1, the ARARs do not apply.

6.2.3 Long-Term Effectiveness and Permanence

Alternative S-5 is rated the highest with respect to long-term effectiveness and permanence because it includes the effective and permanent remedies of off-site removal and disposal from Alternatives S-3, and the parcel-wide covers and institutional controls from Alternative S-4. The long-term permanence is lower for Alternative S-2 and S-4, which rely more heavily on institutional controls to meet the RAOs for the chemicals that are left in place, and higher for Alternatives S-3 and S-5 that implement excavations, which reduce the volume of on-site contaminants. Alternatives S-2 through S-5 would also provide long-term effectiveness in meeting the RAOs through reliance on continual enforcement of covenants to restrict use of property to maintain covers and access restrictions. Alternatives S-3 provides long-term effectiveness and permanence for lead- and PAH-contaminated soil that is excavated but relies on access restrictions for other COCs until the institutional controls are implemented. Alternative S-4 provides a permanent cover prior to development, but does not permanently remove any contamination. Since no action will be taken under Alternative S-1, it does not provide a long-term effective or permanent solution to the soil risks present at the site.

6.2.4 Reduction of Mobility, Toxicity, or Volume through Treatment

None of the alternatives proposed for remediating soils at Parcel D include treatment as a GRA; therefore, all of the alternatives (S-1 through S-5) are rated poor with respect to reducing the mobility, toxicity, or volume through treatment.

6.2.5 Short-Term Effectiveness

Alternative S-1 has the least effect on the community, remedial workers, or the environment by the implementation because it includes no actions. Alternatives S-2 and S-4 introduce less risk to these receptors because they do not include excavation, hauling, and disposal of soil that contains contamination. Alternatives S-3 and S-5 include removing and hauling soils with contamination that would pose potential risk to these receptors, although this risk is considered low and mitigation measures would be implemented.

6.2.6 Implementability

Distinction between the alternatives for implementability is minimal. Alternatives S-2 through S-4 require implementation of institutional controls. Installing covers (Alternative S-4) and excavating soil (Alternatives S-3 and S-5) are standard technologies that are easy to implement. Alternative S-1 does not involve remedial technologies or institutional controls and requires no implementation.

6.2.7 Cost

Alternatives S-1 requires no action; therefore, no costs are associated with this alternative. Alternative S-2 is the least costly ($820,000) because it includes no active remediation prior to property transfer. Alternative S-3 has moderate cost (approximately $1.81 million), and Alternatives S-4 and S-5 that include the covers as a process option have the greatest cost (approximately $4.54 million and $5.5 million). Estimated capital and O&M costs for each alternative are summarized in Table 6-1.

6.2.8 Overall Rating of Soil Alternatives

An overall rating was assigned to each soil alternative (see Table 6-2). Alternatives S-2 through S-5 meet the threshold criteria. Alternative S-5 is rated between very good and excellent overall for the five balancing evaluation criteria under the National Oil and Hazardous Substances Pollution Contingency Plan. Alternative S-5 is the most effective, with both excavation and covers, although it has the highest cost ($5.5 million). Alternative S-3, rated very good, is more effective than Alternative S-2 because contaminants are removed. The cost of Alternative S-3 ($1.81 million) is somewhat more expensive than that of Alternative S-2 ($820,000). Alternative S-4, rated very good, is considerably more expensive but is also more protective than Alternatives S-2 or S-3 ($4.54 million). Alternative S-2, rated good, is easiest to implement and least expensive. Alternative S-1 does not meet the threshold criteria and is thus rated poor.

6.3 INDIVIDUAL ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES

This section evaluates each groundwater alternative in comparison to the seven evaluation criteria discussed in Section 6.0. Table 6-1 presents the cost summary for each alternative, and Table 6-2 provides a summary of each alternative's rating under the two threshold and five balancing NCP evaluation criteria.

6.3.1 Individual Analysis of Alternative GW-1

Under Alternative GW-1, no remedial action would be taken. Groundwater at Parcel D would be left as is, without implementing any institutional controls, containment, removal, treatment, or other response actions. The no action response is retained throughout the FS process as required by the NCP to provide a baseline for comparison to and evaluation of other alternatives.

Table 6-2 summarizes the analysis of Alternative GW-1 relative to the evaluation criteria. The overall rating for this alternative is marginal to good.

6.3.1.1 *Overall Protection of Human Health and the Environment: Alternative GW-1*

Groundwater at Parcel D through the vapor intrusion pathway poses a risk to human health. Alternative GW-1 does not provide treatment or institutional controls to prevent direct exposure to COCs present in groundwater. As a result, Alternative GW-1 is not protective of human health. Alternative GW-1 is rated not protective for the overall protection of human health and the environment.

6.3.1.2 *Compliance with ARARs: Alternative GW-1*

Because no action is proposed, ARARs are not applicable.

6.3.1.3 *Long-Term Effectiveness and Permanence: Alternative GW-1*

The factors evaluated under long-term effectiveness and permanence included the magnitude of residual risks and adequacy and reliability of controls. Under the no action alternative, contaminated groundwater will not be mitigated and this alternative presents a potential unacceptable risk to human health. Because no treatment, engineering controls, or institutional controls would be implemented during this alternative, the adequacy and reliability of controls are poor. The rating for Alternative GW-1 for long-term effectiveness and permanence is poor.

6.3.1.4 *Reduction of Mobility, Toxicity, or Volume through Treatment: Alternative GW-1*

Alternative GW-1 would not reduce the mobility, toxicity, or volume of hazardous substances at Parcel D because groundwater will not be treated, contained, or removed. The overall rating for Alternative GW-1 for the reduction of mobility, toxicity, or volume through treatment is poor.

6.3.1.5 *Short-Term Effectiveness: Alternative GW-1*

Four factors are considered when assessing the short-term effectiveness of an alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy. Each of these factors is assessed below for Alternative GW-1.

- Because no remedial action will be taken, Alternative GW-1 would not present any new health risks to the community and current occupants.
- No remedial action workers would be exposed to health risks.
- No adverse environmental impacts would result from construction and implementation of Alternative GW-1.
- Alternative GW-1 would not require any implementation time.

Based on this evaluation, the overall rating for Alternative GW-1 for the short-term effectiveness is good.

6.3.1.6 Implementability: Alternative GW-1

Implementability includes technical and administrative feasibility and the availability of required resources. No construction or operation is required to implement this alternative. As a result, Alternative GW-1 is technically and administratively feasible and does not require any resources. The overall rating for Alternative GW-1 for implementability is excellent.

6.3.1.7 Cost: Alternative GW-1

No capital or O&M costs are associated with Alternative GW-1. The rating for Alternative GW-1 for costs is excellent.

6.3.1.8 Overall Rating: Alternative GW-1

Alternative GW-1 does not meet the threshold criteria and is unacceptable in terms of long-term effectiveness and reduction of toxicity, mobility, or volume. However, the implementability and cost for this alternative are excellent; therefore, based on a equal weighted rating of the seven criteria, Alternative GW-1 is between marginal and good.

6.3.2 Individual Analysis of Alternative GW-2

Alternative GW-2 consists of institutional controls and long-term monitoring. The institutional controls under this alternative would (1) limit use of property to activities that do not present a potential unacceptable risk due to exposure to contaminated groundwater; (2) require specific actions be taken during redevelopment and reuse to prevent exposure to groundwater that presents a potential unacceptable risk; (3) prohibit access to existing wells from either the A- or B-aquifers; (4) prohibit access to existing structures where there is a potential unacceptable risk through the vapor intrusion pathway; (5) require vapor barriers or other engineering controls beneath the foundations for all new structures; (6) prevent exposing groundwater and creating ecological habitat at the surface through groundwater pumping or other means; and (7) prohibit extraction of groundwater except for short-term construction projects.

Results of the long-term groundwater monitoring program would be used during the 5-year reviews to assess the monitoring program, adjust the data collection and analysis requirements, and evaluate the need for other response actions.

Table 6-2 summarizes the analysis of Alternative GW-2 relative to the evaluation criteria. The overall rating for this alternative is between good and very good.

6.3.2.1 Overall Protection of Human Health and the Environment: Alternative GW-2

Alternative GW-2 would protect human health and the environment because it would prevent direct exposure to contaminated groundwater and to vapors through the implementation of the institutional controls and long-term groundwater monitoring. These institutional controls would prevent exposure of human and ecological receptors to contaminated groundwater; however, active treatment of the contamination in the groundwater is not included in this alternative. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways outside of the planned reuse. Alternative GW-2 is rated protective for the overall protection of human health and the environment criterion.

6.3.2.2 Compliance with ARARs: Alternative GW-2

No chemical-specific ARARs are pertinent to Alternative GW-2 because no active treatment or removal of groundwater is proposed. The location-specific ARARs identified for activities affecting the Bay and the coastal zone at Parcel D would be met. Action-specific ARARs for groundwater monitoring will be met by developing and employing appropriate sampling protocols. Alternative GW-2 meets ARARs.

6.3.2.3 Long-Term Effectiveness and Permanence: Alternative GW-2

The factors evaluated under long-term effectiveness and permanence included the magnitude of residual risks and adequacy and reliability of controls. Under Alternative GW-2, risks due to exposure to groundwater COCs are mitigated by preventing the exposure pathway to potential human receptors. The potential risks from the contaminated groundwater migrating to the Bay remains unchanged. However, the development of attenuation factors for the metals plumes, and the subsequent comparison of the trigger levels with the surface water criteria will show whether migration of the plumes from the plume source to the Bay will result in a potential concern for the protection of the Bay. Short-term monitoring may yield sufficient data for the metals to support this alternative.

The adequacy and reliability of this alternative depend on (1) the maintenance and enforcement of access restrictions; and (2) the reliability of the long-term monitoring program. A LUC RD would be prepared to guide implementation of covenants to restrict use of property, and inspection for compliance and enforcement for the institutional controls and the groundwater monitoring program. Overall, the rating for Alternative GW-2 for the long-term effectiveness and permanence is good.

6.3.2.4 *Reduction of Mobility, Toxicity, or Volume through Treatment: Alternative GW-2*

Alternative GW-2 would not reduce the mobility, toxicity, or volume of the contamination through treatment. The institutional controls for this alternative are intended to prevent exposure to groundwater COCs while contaminants are allowed to naturally attenuate. The overall rating for Alternative GW-2 for reducing the mobility, toxicity, or volume through treatment is poor.

6.3.2.5 *Short-Term Effectiveness: Alternative GW-2*

Four factors are considered when assessing the short-term effectiveness of an alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy. Each of these factors is assessed below for Alternative GW-2.

Alternative GW-2 would not present any new risks to the community and current occupants. Minimal health risks would be posed by the long-term monitoring that would periodically extract and collect small amounts of groundwater for sampling.

No remedial action workers would be exposed to risks because no active remedy to groundwater would be applied. Minimal risk to the workers would be posed during the groundwater sampling events, but proper personal protective equipment and appropriate health and safety protocols would minimize these risks.

No adverse environmental impacts would result from construction and implementation of Alternative GW-2 because no groundwater treatment is proposed for this alternative. Minimal exposure to groundwater would occur during the long-term groundwater sampling program.

The institutional controls for Alternative GW-2 would likely be implemented in less than 6 months. Long-term monitoring would occur over 30 years, although the field activities for this monitoring occur for short periods with long intervals of no activity.

Based on this evaluation, the overall rating for Alternative GW-2 for the short-term effectiveness is very good.

6.3.2.6 *Implementability: Alternative GW-2*

Implementability includes technical and administrative feasibility and the availability of required resources. No construction or O&M would be required to implement Alternative GW-2; therefore, this alternative is technically and administratively feasible. Long-term groundwater monitoring is a routine activity and requires a moderate level of routinely available resources; however, the duration of monitoring may be up to 30 years. The overall rating for Alternative GW-2 for implementability is very good.

6.3.2.7 Cost: Alternative GW-2

The total capital and O&M costs for Alternative GW-2 are presented in Table 6-1 and detailed in Appendix F. The costs to implement the institutional controls are low, and the cost to implement the long-term monitoring is moderately high. The overall rating of Alternative GW-2 for cost is good.

6.3.2.8 Overall Rating: Alternative GW-2

Alternative GW-2 meets ARARs and protects human health through institutional controls. The environment is protected with a long-term monitoring program that includes monitoring of the metals plumes as they migrate to the Bay. This alternative is easily implemented with minimal impact to the community. However, it is not effective in reducing toxicity or mobility of contaminants because this alternative does not treat the contaminated groundwater. The overall rating for this alternative is between good and very good.

6.3.3 Individual Analysis of Alternatives GW-3A and GW-3B

Alternatives GW-3A and GW-3B consist of implementation of institutional controls, *in situ* injection treatments of the groundwater plumes for VOCs, groundwater monitoring for VOCs during and following *in situ* treatment, and groundwater monitoring for metals. The reduced groundwater monitoring for VOCs is designed to demonstrate the effectiveness of the treatment, and would occur for significantly less time as compared to the groundwater monitoring under Alternative GW-2. The groundwater monitoring for metals will occur during a time frame similar to the monitoring approach outlined under Alternative GW-2, and will likely be the same as the monitoring time needed to demonstrate the successful treatment of the VOC plumes to less than the remedial goals.

The treatment additive for Alternative GW-3A is a bioremediation substrate compound that enhances anaerobic bioremediation by releasing hydrogen. Alternative GW-3B uses ZVI as the treatment additive. The only difference in the alternatives is the treatment additive. Treatment design is the same for Alternatives GW-3A and GW-3B, with the same well spacing and depths. The volume of ZVI treatment additive is approximately 25 times the volume of the bioremediation substrate. The chemical action of the ZVI in the aquifer is more immediate than the bioremediation reaction. The advantage of slower reacting bioremediation substrate is the continued reaction as the substrate disperses, potentially creating a wider treatment area, and the continued treatment for potential "rebound" conditions. Both approaches are effective for all VOCs, and the primary difference is the total cost of the additives.

Table 6-2 summarizes the analysis of Alternative GW-3A and GW-3B relative to the evaluation criteria.

6.3.3.1 Overall Protection of Human Health and the Environment: Alternatives GW-3A and GW-3B

Alternatives GW-3A and GW-3B will protect human health and the environment because both accelerate the *in situ* degradation of VOCs through injection treatment. Both will prevent direct exposures to contaminated groundwater that may result from unanticipated groundwater uses at the site through implementation of institutional controls. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways outside of the planned reuse. Alternatives GW-3A and GW-3B are rated as protective for the overall protection of human health and the environment criterion.

6.3.3.2 Compliance with ARARs: Alternatives GW-3A and GW-3B

Chemical-specific ARARs pertinent to Alternative GW-3A and GW-3B will be met through institutional controls. The location-specific ARARs identified for activities affecting the Bay and the coastal zone at Parcel D will also be met. Action-specific ARARs will be met through design of a treatment approach that prevents downward migration of contaminants to a drinking water aquifer. No chemical-specific ARARs are pertinent to the groundwater monitoring for metals because no active treatment or removal of groundwater is proposed for this portion of either alternative. Alternatives GW-3A and GW-3B meet ARARs.

6.3.3.3 Long-Term Effectiveness and Permanence: Alternatives GW-3A and GW-3B

The factors evaluated under long-term effectiveness and permanence included the magnitude of residual risks and the adequacy and reliability of controls. Under Alternatives GW-3A and GW-3B, risks from groundwater contaminated by VOCs would be mitigated by preventing a complete exposure pathway to potential human receptors. The potential for metals-contaminated groundwater to migrate to the Bay is marginally reduced. The risk of inadvertent contamination of the Bay is greatly reduced because groundwater monitoring would provide advance warning of migration into the Bay and would trigger further study or remedial measures. Furthermore, predicted concentrations (based on attenuation factors) at downgradient measurement points are lower than the trigger levels (Section 3.3.4.1). The metals in groundwater will also be precipitated in the reducing environment produced during treatment of VOCs in areas where the VOC and metals plumes are collocated. Therefore, this alternative is expected to be protective against exposure to metals and VOCs in the long term. The volume and toxicity of the VOC-contaminated groundwater would be reduced through *in situ* treatment. The adequacy and reliability of this alternative also depend on the (1) maintenance and enforcement of the access restrictions; (2) the reliability of the monitoring program for metals; and (3) the reliability of metals monitoring or the verification of the plume-specific attenuation factors used to derive the chemical-specific trigger levels. An LUC RD will be prepared to guide implementation of covenants to restrict use of property, and inspection for compliance and enforcement for the institutional controls and the groundwater monitoring program. The process for evaluating metals will be established in the monitoring program, including verification of the plume-specific attenuation factors used to derive the chemical-specific trigger levels for metals. The overall rating for Alternatives GW-3A and GW-3B for the long-term effectiveness and permanence is very good.

6.3.3.4 Reduction of Mobility, Toxicity, or Volume through Treatment: Alternatives GW-3A and GW-3B

Alternatives GW-3A and GW-3B will reduce the toxicity and volume of VOCs in groundwater at Parcel D through *in situ* groundwater treatment. The risk of potential VOC mobility would be addressed through proper design and implementation of the treatment system and implementation of a groundwater monitoring program. Injections would be initially implemented below the elevation of groundwater contaminants to prevent downward migration. Monitoring would continue until the treatment is successful in reducing the concentrations to acceptable levels. The institutional controls would remain in effect to address residual contamination until acceptable levels are reached. This alternative would not reduce the mobility, toxicity, or volume of metal contaminants through active remediation, except, possibly, in areas where the VOC plumes and the metals plumes are collocated. This is because the *in situ* reaction that reduces the VOC concentrations will also mitigate the metals concentrations. The institutional controls for metals are intended to prevent exposure to groundwater COCs while contaminants are allowed to naturally attenuate or while the monitoring program is implemented to verify the plume-specific attenuation factors used to derive the chemical-specific trigger levels. The overall rating for Alternatives GW-3A and GW-3B for the reduction of mobility, toxicity, or volume through treatment is good.

6.3.3.5 Short-Term Effectiveness: Alternatives GW-3A and GW-3B

Four factors were considered when assessing the short-term effectiveness of Alternatives GW-3A and GW-3B: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy. Each of these factors is assessed below for Alternatives GW-3A and GW-3B.

Under Alternatives GW-3A and GW-3B, the VOC treatment remedy would not present health risks to the community and current occupants, because the remedial action is applied as an *in situ* injection, and the treatment additives are not toxic. The risk from groundwater monitoring would be minimal and is less than the long-term monitoring proposed for Alternative GW-2 due to the shorter duration of monitoring. Groundwater monitoring for metals would not present any new risks to the community and current occupants and is anticipated to be the same duration of monitoring required to demonstrate that the VOC treatment is complete. Minimal health risks would be posed by the long-term monitoring that would include periodic extraction and collection of small amounts of groundwater for sampling.

Workers applying the VOC treatment would not be exposed to the contaminated groundwater, because the remedial action is applied as an *in situ* injection. The risk to the workers during groundwater monitoring would be minimized through the use of proper handling of groundwater samples and appropriate personal protective equipment during sampling efforts. Remediation would be performed under a health and safety program to prevent worker injuries.

Environmental impacts in the areas where the injection treatment would be applied are minor due to the industrial use of the areas. Similarly, the short-term increase in traffic during active treatment and monitoring would have minimal environmental impact. No adverse environmental impacts would result from construction and implementation of the groundwater monitoring for metals because no groundwater treatment is proposed for metals in this alternative.

Active treatment under Alternatives GW-3A and GW-3B would likely be implemented in less than 1 year. The reduced groundwater monitoring for VOC plumes is anticipated to be complete within 5 years; however, the monitoring duration must demonstrate the effectiveness of the treatment, and the permanent reduction of the VOCs in the groundwater. Groundwater monitoring for metals is anticipated to be complete within 5 years.

The overall rating for Alternatives GW-3A and GW-3B for the short-term effectiveness is very good.

6.3.3.6 Implementability: Alternatives GW-3A and GW-3B

Implementability includes technical and administrative feasibility and the availability of required resources. Two pilot studies at HPS demonstrated that injection treatment is feasible at HPS (Shaw Environmental, Inc. 2005; Tetra Tech 2003b). Treatment requires a moderate level of resources for a short duration. The major difficulty with implementing injection technologies during pilot studies at HPS has been mass transfer of the treatment substrate to the contaminants. Data from pilot studies as well as the lithology of the treatment area will be used to determine sufficient injection points for treatment additives to optimize their success. Groundwater monitoring is a routine activity and requires a moderate level of resources. The overall rating for Alternatives GW-3A and GW-3B for implementability is very good.

6.3.3.7 Cost: Alternatives GW-3A and GW-3B

The total capital and O&M costs for Alternatives GW-3A and GW-3B are presented in Table 6-1 and detailed in Appendix F. The costs to implement the institutional controls are low, and the cost to implement the monitoring program is moderate. The costs for *in situ* treatment are moderate for Alternative 3A and very high for Alternative 3B. The cost to implement the monitoring of groundwater for metals is moderate.

The costs for implementing the *in situ* treatments for Alternatives GW-3A and GW-3B were derived from the HPS ZVI pilot study (Alternative GW-3B) and vendor information for substrates for biodegradation of VOCs (Alternative GW-3A) (see Appendix F). These volume assumptions were based on the volume of treatment additive per foot thickness of aquifer to be treated from the vendor's estimation, compared to the volume of ZVI per foot of thickness of aquifer that was treated during the ZVI pilot study treatment at HPS. The spacing for the treatment injection points proposed by the remediation product vendor was approximately the same as the treatment spacing used for the ZVI pilot study. Based on these assumptions, the difference in costs of Alternative GW-3A to apply the VOC treatment compounds, compared to the costs of Alternative GW-3B to apply the ZVI additive, is the difference in the cost of the additives. It was found that the cost of the ZVI additive per pound is one-third the cost of the bioremediation substrate additive. However, the treatment for the same volume of contaminated groundwater requires approximately 25 times the volume of ZVI; therefore, the total capital cost of the ZVI additives will be 8 to 10 times the cost of the total capital cost of the bioremediation substrate.

The overall rating for Alternative GW-3A for cost of implementing is good, and the overall rating for Alternative GW-3B for cost of implementing is marginal.

6.3.3.8 Overall Rating: Alternatives GW-3A and GW-3B

Alternatives GW-3A and GW-3B meet ARARs and protect human health and the environment through active treatment as well as institutional controls. The environment is further protected with a monitoring program for metals and VOCs that includes an assessment of the plume-specific attenuation factors that were used to derive the chemical-specific trigger levels for metals, which demonstrate no risk from the potential migration of groundwater to the Bay. These alternatives are easily implemented with minimal impact to the community. These alternatives effectively reduce toxicity, mobility, and volume of VOC contaminants through treatment but do not reduce toxicity, mobility, and volume of metal contaminants, except in the areas where the VOC and metals plumes are collocated. Both alternatives are designed to treat VOCs. The overall estimated rating for Alternative GW-3A, with lower cost, is between very good and excellent. The overall rating for Alternative GW-3B, with higher costs, is between good and very good.

6.3.4 Individual Analysis of Alternatives GW-4A and GW-4B

Alternatives GW-4A and GW-4B consist of implementation of institutional controls, *in situ* injection treatments of the groundwater plumes, and groundwater monitoring during and following *in situ* treatment. The groundwater monitoring is designed to demonstrate the effectiveness of the treatment, and will occur for significantly less time as compared to the groundwater monitoring under Alternative GW-2. The treatment additive for Alternative GW-4A is a bioremediation substrate compound that enhances anaerobic bioremediation by releasing hydrogen. For plumes where metals are COCs, the remediation compound includes a sulfur-containing substrate that combines the metal into a sulfur-mineral complex that is more readily sorbed to the soil, and removes the dissolved metals from the groundwater. Alternative GW-4B uses ZVI as the treatment additive. The only difference in the alternatives is the treatment additive. Treatment design is the same for Alternatives GW-4A and GW-4B, with the same well spacing and depths. The volume of ZVI treatment additive is approximately 25 times the volume of the bioremediation substrate. The chemical action of the ZVI in the aquifer is more immediate than the bioremediation reaction. The advantage of slower reacting bioremediation substrate is the continued reaction as the substrate disperses, potentially creating a wider treatment area, and the continued treatment for potential "rebound" conditions. Both approaches are effective for all COCs, and the primary difference is the total cost of the additives.

Table 6-2 summarizes the analysis of Alternative GW-4A and GW-4B relative to the evaluation criteria.

6.3.4.1 Overall Protection of Human Health and the Environment: Alternatives GW-4A and GW-4B

Alternatives GW-4A and GW-4B will protect human health and the environment because both accelerate the degradation of contaminants through injection treatment. Both will prevent exposures to contaminated groundwater that may result from unanticipated groundwater uses at the site through implementation of institutional controls as described under GW-2. Alternative GW-4A and GW-4B are rated protective for the overall protection of human health and the environment criterion.

6.3.4.2 Compliance with ARARs: Alternatives GW-4A and GW-4B

Chemical-specific ARARs pertinent to Alternative GW-4A and GW-4B will be met through institutional controls and active treatment of contaminants in the groundwater to acceptable risk levels. The location-specific ARARs identified for activities affecting the Bay and the coastal zone at Parcel D will also be met. Action-specific ARARs will be met through design of a treatment approach that prevents downward migration of contaminants to a drinking water aquifer. Institutional controls will also require that land uses defined in the ROD be maintained, preventing exposure pathways outside of the planned reuse. Alternatives GW-4A and GW-4B meet ARARs.

6.3.4.3 Long-Term Effectiveness and Permanence: Alternatives GW-4A and GW-4B

The factors evaluated under long-term effectiveness and permanence included the magnitude of residual risks and adequacy and reliability of controls. Under Alternative GW-4A and GW-4B, risks from groundwater contaminated by metals and VOCs would be mitigated by preventing a complete exposure pathway to potential human receptors. The risk of inadvertent contamination of the Bay is greatly reduced because groundwater monitoring would provide advance warning of migration into the Bay and would trigger further study or remedial measures. Furthermore, predicted concentrations (based on attenuation factors) at downgradient measurement points are lower than the trigger levels (Section 3.3.4.1). The volume and toxicity of the metal and VOC-contaminated groundwater would be reduced through *in situ* treatment. The adequacy and reliability of this alternative also depend on the (1) maintenance and enforcement of the access restrictions; (2) the reliability of the monitoring program for metals; and (3) the reliability of metals monitoring or the verification of the plume-specific attenuation factors used to derive the chemical-specific trigger levels. A LUC RD will be prepared to guide implementation of covenants to restrict use of property, and inspection for compliance and enforcement for the institutional controls and the groundwater monitoring program. The process for evaluating metals will be established in the monitoring program, including verification of the plume-specific attenuation factors used to derive the chemical-specific trigger levels for metals. The overall rating for Alternatives GW-4A and GW-4B for the long-term effectiveness and permanence is excellent.

6.3.4.4 Reduction of Mobility, Toxicity, or Volume through Treatment: Alternatives GW-4A and GW-4B

Alternatives GW-4A and GW-4B will reduce the toxicity and volume of the COCs in groundwater at Parcel D through *in situ* groundwater treatment. The risk of potential COC mobility would be addressed through proper design and implementation of the treatment and implementation of a groundwater monitoring program. Injections would be initially implemented below the elevation of groundwater contaminants to prevent downward migration. Monitoring would continue until the treatment is successful in reducing the concentrations to acceptable levels. The institutional controls would remain in effect to address residual contamination. The overall rating for Alternatives GW-4A and GW-4B for the reduction of mobility, toxicity, or volume through treatment is excellent.

6.3.4.5 Short-Term Effectiveness: Alternatives GW-4A and GW-4B

Four factors were considered when assessing the short-term effectiveness of Alternatives GW-4A and GW-4B: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts resulting from construction and implementation of the alternative, and (4) time required to implement the remedy. Under Alternatives GW-4A and GW-4B, the treatment remedy would not present health risks to the community and current occupants, because the remedial action is applied as an *in situ* injection, and the treatment additives are not toxic. The risk from groundwater monitoring would be minimal and is less than the long-term monitoring proposed for Alternative GW-2 due to the shorter duration of monitoring.

Workers applying the treatment would not be exposed to the contaminated groundwater, because the remedial action is applied as an *in situ* injection. The risk to the workers during groundwater monitoring would be minimized through the use of proper handling of groundwater samples and appropriate personal protective equipment during sampling efforts. Remediation would be performed under a health and safety program to prevent worker injuries.

Environmental impacts in the areas where the injection treatment would be applied are minor due to the industrial use of the areas. Similarly, the short-term increase in traffic during active treatment and monitoring would have minimal environmental impact.

Active treatment under Alternatives GW-4A and GW-4B would likely be implemented in less than 1 year. Although groundwater monitoring is anticipated to be complete within 5 years, the monitoring duration must demonstrate the effectiveness of the treatment, and the permanent reduction of the COCs and potential COCs in the groundwater.

The overall rating for Alternatives GW-4A and GW-4B for the short-term effectiveness is very good.

6.3.4.6 Implementability: Alternatives GW-4A and GW-4B

Implementability includes technical and administrative feasibility and the availability of required resources. Two pilot studies at HPS demonstrated that injection treatment is feasible at HPS (Shaw Environmental, Inc. 2005; Tetra Tech 2003b). Treatment requires a moderate level of resources for a short duration. The major difficulty with implementing injection technologies during pilot studies at HPS has been mass transfer of the treatment substrate to the contaminants. Data from pilot studies as well as the lithology of the treatment area will be used to determine sufficient injection points for treatment additives to optimize their success.

Groundwater monitoring is a routine activity and requires a moderate level of resources, but would be less than the resources needed for Alternative GW-2 due to the shorter duration of the required monitoring.

The overall rating for Alternatives GW-4A and GW-4B for implementability is very good.

6.3.4.7 Cost: Alternatives GW-4A and GW-4B

The total capital and O&M costs for Alternatives GW-4A and GW-4B are presented in Table 6-1 and detailed in Appendix F. The costs to implement the institutional controls are low, and the cost to implement the monitoring program is moderate. The costs for *in situ* treatment are moderately high for Alternative GW-4A and very high for Alternative GW-4B.

The costs for implementing the *in situ* treatments for Alternatives GW-4A and GW-4B were derived from the HPS ZVI pilot study (Alternative GW-4B) and vendor information for metals treatment compound and substrates for biodegradation of VOCs (Alternative GW-4A) (see Appendix F). These volume assumptions were based on the volume of treatment additive per foot thickness of aquifer to be treated from the vendor's estimation, compared to the volume of ZVI per foot of thickness of aquifer that was treated during the ZVI pilot study treatment at HPS. The spacing for the treatment injection points proposed by the remediation product vendor was approximately the same as the treatment spacing used for the ZVI pilot study. Based on these assumptions, the difference in costs of Alternative GW-4A to apply the metals or VOC treatment compounds, compared to the costs of Alternative GW-4B to apply the ZVI additive, is the difference in the cost of the additives. It was found that the cost of the ZVI additive per pound is one-third the cost of the bioremediation substrate additive. However, the treatment for the same volume of contaminated groundwater requires approximately 25 times the volume of ZVI; therefore, the total capital cost of the ZVI additives will be 8 to 10 times the cost of the total capital cost of the bioremediation substrate.

The overall rating for Alternative GW-4A for cost of implementing is good, and the overall rating for Alternative GW-4B for cost of implementing is poor.

6.3.4.8 *Overall Rating: Alternatives GW-4A and GW-4B*

Alternatives GW-4A and GW-4B meet ARARs and protect human health and the environment through active treatment as well as institutional controls. The environment is further protected with a monitoring program that demonstrates the success of the treatments. These alternatives are easily implemented with minimal impact to the community. Additionally, these alternatives effectively reduce toxicity, mobility, and volume of contaminants through treatment. Alternative GW-4A is specifically designed to treat VOCs and metals such as chromium VI and nickel. Alternative GW-4B also provides the reducing conditions that treat VOCs and foster the precipitation of metals. However, the costs of Alternative GW-4B are very high. The overall estimated rating for Alternatives GW-4A, with lower cost, is excellent. The overall rating for GW-4B, with the much higher cost, is very good.

6.4 COMPARISON OF GROUNDWATER REMEDIAL ALTERNATIVES

This section compares the six groundwater alternatives in terms of the nine evaluation criteria. The discussion of each evaluation criterion generally proceeds from the alternative that best satisfies the criterion to the one that least satisfies the criterion. Table 6-2 summarizes the ratings for each alternative and shows a comparison of each alternative's ratings for the seven evaluation criteria.

6.4.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is a threshold criterion. Protection is not measured by degree; rather, each alternative is considered either protective or not protective. Alternatives GW-2, GW-3A, GW-3B, GW-4A, and GW-4B are protective. Alternative GW-1 is not protective.

6.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

Compliance with ARARs is a threshold evaluation criterion. An alternative must either comply with ARARs or provide grounds for a waiver. Alternatives GW-4A and GW-4B meet all of the pertinent ARARs. Alternatives GW-2, GW-3A, and GW-3B also meet all of the pertinent ARARs, but with potentially less certainty. ARARs do not apply to the no action alternative, Alternative GW-1.

6.4.3 Long-Term Effectiveness and Permanence

Alternatives GW-4A and GW-4B would provide the highest level of long-term effectiveness and permanence, because COCs would be degraded or immobilized. Alternative GW-2 would provide a moderate level of effectiveness and permanence because groundwater plumes would be addressed only through institutional controls and monitoring to assess the potential migration of contaminants. Alternatives GW-3A and GW-3B would provide a higher level of long-term effectiveness and permanence than Alternative GW-2, because VOCs would be degraded or immobilized but metals would be addressed through institutional controls and monitoring, using the plume-specific attenuation factors and the chemical-specific trigger levels for metals. All alternatives, except for Alternative GW-1 provide an adequate and reliable level of controls.

6.4.4 Reduction of Mobility, Toxicity, or Volume through Treatment

Alternatives GW-4A and GW-4B are rated the highest because they both reduce the toxicity and volume of the contaminants by active treatment of the VOCs, and the chromium VI and nickel plumes. The treatment would also reduce the mobility of the chromium VI and nickel plumes by *in situ* precipitation of the metals from their dissolved phase. Mobility of these contaminants would be monitored and human health risk assessment exposure would be eliminated through institutional controls. Alternatives GW-3A and GW-3B would reduce the toxicity or volume of VOC contaminants through treatment, but would monitor the mobility of the metals contamination through the groundwater monitoring program and eliminate exposure through the use of institutional controls. Alternative GW-2 would not reduce the toxicity or volume of contaminants, and would also monitor the mobility of the contamination through the groundwater monitoring program and eliminate exposure through the use of institutional controls. Alternative GW-1 does not reduce the mobility, toxicity, or volume of contaminants in the groundwater.

6.4.5 Short-Term Effectiveness

All of the alternatives scored well in terms of short-term effectiveness according to the criteria. Alternatives GW-3A, GW-3B, GW-4A, and GW-4B pose a slightly greater risk through use of active *in situ* treatment compared with Alternative GW-2. Alternatives GW-2, GW-3A, GW-3B, GW-4A, and GW-4B all pose a very low risk to workers during implementation of the groundwater monitoring program. Alternative GW-2 may pose a slightly greater risk than Alternatives GW-3A, GW-3B, GW-4A, and GW-4B because the long-term groundwater monitoring involves more sampling events. Alternative GW-1 has an excellent short-term effectiveness rating as no remedial actions are conducted under this alternative.

6.4.6 Implementability

Alternatives GW-1 and GW-2 have the highest rating and are technically the easiest to implement. Alternative GW-2 would require greater resources to conduct the long-term groundwater monitoring program; however, these resources are readily available. Alternatives GW-3A, GW-3B, GW-4A, and GW-4B are more complex to implement because of the injection treatment; however, this treatment is a one-time injection that would reduce the resources required for groundwater monitoring as compared to Alternative GW-2. Alternatives GW-3A and GW-4A may be easier to implement because the injected substrates are slow-release compounds that continue to degrade or precipitate COCs over time. This increases the potential to react with contaminants as the contaminants disperse in the aquifer.

6.4.7 Cost

Estimated total capital costs for each alternative are summarized in Table 6-1. Alternative GW-1 is rated the highest because it has no associated cost because no actions would be taken. Alternative GW-3A has a moderate cost (approximately $2.45 million), due to *in situ* treatment of VOCs and long-term monitoring of metals. Alternative GW-2 has slightly higher costs (approximately $3.52 million), most of which is for the 30 years of long-term monitoring. Alternatives GW-4A has a similar cost (approximately $2.87 million). Alternative GW-3B has the second highest capital cost because of the cost of the ZVI additive treatment for VOC plumes ($5.35 million). Alternative GW-4B has the highest capital cost because of the cost of the ZVI additive treatment for both VOC and metal plumes ($9.2 million).

6.4.8 Overall Rating of Groundwater Alternatives

An overall rating was assigned to each groundwater alternative (see Table 6-2). Alternative GW-3A and GW-4A both have the highest overall rating of between very good and excellent with Alternative GW-4A being slightly higher. These treatments effectively reduce risks to human health and environment, and have similar costs (GW-3A of $2.45 million and GW-4A of $2.87 million). In the long term, Alternative GW-4A is expected to be more likely to achieve remedial action objectives than Alternative GW-3A because the latter alternative does not actively treat metals in groundwater. Alternative GW-3B ranks very good, but has a higher cost ($5.35 million) and does not actively treat metals in groundwater. Alternative GW-4B ranks very good also, but at an even higher cost ($9.2 million). Alternative GW-2 is easy to implement at a cost similar to Alternatives GW-3A and GW-3B ($3.52 million), but it is not as effective as GW-3A, GW-3B, GW-4A, and GW-4B. Alternative GW-1 is rated as a poor alternative because it does not meet the threshold criteria.

TABLES

TABLE 6-1: SUMMARY OF COSTS FOR SOIL AND GROUNDWATER ALTERNATIVES

Revised Feasibility Study for Parcel D, Hunters Point Shipyard, San Francisco, California

Remedial Alternative	Capital Cost	Periodic Cost	Contingency Cost	Total Cost
Soil				
Alternative S-1: No Action	$0	$0	$0	$0
Alternative S-2: Institutional Controls	$370,000	$315,000	$135,000	$820,000
Alternative S-3: Excavation, Disposal, and Institutional Controls	$1,220,000	$290,000	$300,000	$1,810,000
Alternative S-4: Covers and Institutional Controls	$2,380,000	$1,400,000	$760,000	$4,540,000
Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls	$3,160,000	$1,425,000	$915,000	$5,500,000
Groundwater				
Alternative GW-1: No Action	$0	$0	$0	$0
Alternative GW-2: Long-Term Monitoring and Institutional Controls	$280,000	$2,655,000	$585,000	$3,520,000
Alternative GW-3A: *In Situ* VOC Plume Treatment with Bio-degradation Substrate, Reduced Groundwater Monitoring, and Institutional Controls[1]	$690,000[1]	$1,350,000	$410,000	$2,450,000
Alternative GW-3B: *In Situ* VOC Plume Treatment with ZVI Injection, Reduced Groundwater Monitoring, and Institutional Controls[1]	$3,110,000	$1,350,000	$890,000	$5,350,000
Alternative GW-4A: *In Situ* VOC and Metals Plume Treatment with Bio-degradation Substrate, Reduced Groundwater Monitoring, and Institutional Controls[1]	$1,040,000[1]	$1,350,000	$480,000	$2,870,000
Alternative GW-4B: *In Situ* VOC and Metals Plume Treatment with ZVI Injection, Reduced Groundwater Monitoring, and Institutional Controls[1]	$6,320,000	$1,350,000	$1,530,000	$9,200,000

Notes:

Capital Costs are present worth cost assuming immediate expenditure.
Periodic Costs are 30-year present worth costs over a period of 30 years.
Contingency Costs are 20 percent of the sum of the present worth capital cost, and the present worth O&M costs.
Total Costs are the sum of the present worth capital cost, the present worth O&M costs, and the contingency costs.

1 The analysis of Alternatives GW-3A, GW-3B, GW-4A, and GW-4B were based on a general *in situ* injection treatment.

O&M Operation and maintenance
ZVI Zero-valent iron

TABLE 6-2: RANKING OF REMEDIAL ALTERNATIVES FOR SOIL AND GROUNDWATER
Revised Feasibility Study Report for Parcel D, Hunters Point Shipyard, San Francisco, California

	Overall Protection of Human Health and the Environment[a]	Compliance with ARARs[a]	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost	Overall Rank by Alternative
SOIL ALTERNATIVES								
Alternative S-1: No Action	Not protective	Not Applicable	○	○	◕	●	●	◐
Alternative S-2: Institutional Controls and Maintained Landscaping	Protective	Meets ARARs	◔	○	◕	◐	●	◕
Alternative S-3: Excavation, Disposal, Maintained Landscaping, and Institutional Controls	Protective	Meets ARARs	◐	○	◕	◕	◕	◕
Alternative S-4: Covers and Institutional Controls	Protective	Meets ARARs	◕	○	◕	◕	◐	◕
Alternative S-5: Excavation, Disposal, Covers, and Institutional Controls	Protective	Meets ARARs	●	○	●	◕	◐	◕
GROUNDWATER ALTERNATIVES								
Alternative GW-1: No Action	Not protective	Not Applicable	○	○	◐	◕	●	◔
Alternative GW-2: Long-Term Monitoring and Institutional Controls	Protective	Meets ARARs	◐	○	◕	◕	◐	◕
Alternative GW-3A: In-Situ Treatment for VOCs with a Bioremediation Compound with Reduced Groundwater Monitoring and Institutional Controls	Protective	Meets ARARs	◕	◐	◕	◕	◐	●
Alternative GW-3B: In-Situ Treatment for VOCs with ZVI Injection with Reduced Groundwater Monitoring and Institutional Controls	Protective	Meets ARARs	◕	◐	◕	◕	◔	◕
Alternative GW-4A: In-Situ Treatment for VOCs and Metals with Bioremediation Compound with Reduced Groundwater Monitoring, and Institutional Controls	Protective	Meets ARARs	●	●	◕	◕	◐	●
Alternative GW-4B: In-Situ Treatment for VOCs and Metals with ZVI Injection with Reduced Groundwater Monitoring and Institutional Controls	Protective	Meets ARARs	●	●	◕	◕	○	◕

Notes:

a	Overall protection of human health and the environment and compliance with ARARRs are threshold criteria and alternatives are judged as either meeting or not meeting the criteria.
ARAR	Applicable or relevant and appropriate requirement
ZVI	Zero-valent iron

Legend:

○	Poor
◔	Marginal
◐	Good
◕	Very Good
●	Excellent

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